2mix

SCI

CR-120167

(NASA-CR-120167) A SATURN LAUNCHED X-RAY ASTRONOMY EXPERIMENT. VOLUME 2: S-150 Final Program Report (SCI Electronics, Inc.) 92 p HC $7.75 CSCL 03A

N74-21428

Unclas
G3/30 16479

A SATURN LAUNCHED SOFT X-RAY ASTRONOMY EXPERIMENT

FINAL PROGRAM REPORT

VOLUME II

S-150

SUBMITTED IN ACCORDANCE WITH

SUBCONTRACT NO. 1

UNDER PRIME NASA CONTRACT NAS 8-21015

UNIVERSITY OF WISCONSIN

ORIGINAL

SCI SYSTEMS, INC.

HUNTSVILLE DIVISION

A SATURN LAUNCHED

SOFT X-RAY ASTRONOMY EXPERIMENT

FINAL PROGRAM REPORT

VOLUME II

S-150

SUBMITTED IN ACCORDANCE WITH

SUBCONTRACT NO. 1

UNDER PRIME NASA CONTRACT NAS 8-21015

UNIVERSITY OF WISCONSIN

ORIGINAL

PREPARED BY

SCI SYSTEMS, INC.

8620 SOUTH MEMORIAL PARKWAY

HUNTSVILLE, ALABAMA

I

FORWARD

The final program report for the Saturn Launched X-Ray Astronomy Experiment is comprised of two (2) volumes. The first volume describes the original X-Ray Experiment, designated S-027, with a sensitivity range from 2 Kev to 10 Kev. The second volume describes the soft X-Ray Version, designated S-150, with a sensitivity range from 200 ev to 10 Kev.

PHASE TWO

FINAL REPORT

FOR

S-150

X-RAY ASTRONOMY

ORIGINAL

APPROVALS

G. Frohwein, Project Engineer
Special Projects Section

Aug 24, 73
Date

Don Norris for Tom Freisen
T.H. Freisen, Manager
Special Projects Section

24 AUGUST 1973
Date

TABLE OF CONTENTS

1.0 SUMMARY

2.0 INTRODUCTION

3.0 EXPERIMENT DISCUSSION

- 3.1 SIGNAL DETECTION SYSTEM
- 3.2 DIGITAL DATA PROCESSING
- 3.3 VETO SYSTEM
- 3.4 STAR SENSORS
- 3.5 CALIBRATION MECHANISM
- 3.6 GAS SYSTEM

4.0 SUBSYSTEM DESCRIPTION

- 4.1 BUFFER AMPLIFIERS
- 4.2 FIVE LEVEL DISCRIMINATORS
- 4.3 HIGH VOLTAGE POWER SUPPLIES
- 4.4 HIGH VOLTAGE CONTROL CIRCUIT
- 4.5 VETO DELAY CIRCUIT
- 4.6 THRESHOLD DESCRIMINATORS
- 4.7 ANALOG SIGNAL CONDITIONER
- 4.8 STAR SENSOR AMPLIFIERS
- 4.9 LOW VOLTAGE POWER SUPPLY
- 4.10 DIGITAL DATA PROCESSOR

5.0 ENVIRONMENTAL TEST

6.0 GROUND SUPPORT EQUIPMENT

6.1 ANALOG PROCESSING AND DISPLAY UNIT

6.2 DIGITAL PROCESSING AND DISPLAY UNIT

7.0 CONCLUSION

1.0 SUMMARY

After the S-027 launch delay became official, it was apparent that the delay would be for several years and that the scientific value of S-027 experiment would be greatly diminished since several other similar experiments would be launched prior to the new S-027 launch date.

This would mean that the S-027 experiment would only provide redundant data for the earlier experiments.

In order to develop an experiment which would provide previously unknown information at the projected new launch period, a decision was made to modify the S-027 experiment to allow detection of lower energies which had previously not been mapped. The modification basically required that the static counters by replaced with a thin film entrance window gas flow counter which would allow detection of X-Ray energies as low as 150 ev. The new experiment designated S-150 was designed to detect X-Ray energies over a spectrum of 150 ev to 10 Kev. Photographs of the S-150 experiment are shown in Figures 1-1, 1-2 and 1-3. Basically the same signal detection and processing techniques were used on the S-150 experiment as were used on the S-027. For economic reasons much of the S-027 subassembly hardware was used on the new experiment. The main design changes were in the signal detection system and the high energy veto system.

The S-150 was flown as part of the Sky Lab Program on Skylab III in July 1973.

The experiment flew as a secondary mission in that it was passive until the primary mission - that of orbiting the command module - was completed and the CSM was separated from the I. U. After CSM separation, the experiment was actuated and provided useful data for at least the first orbit when a leak developed in the thin window and pressure was reduced beyond operational level.

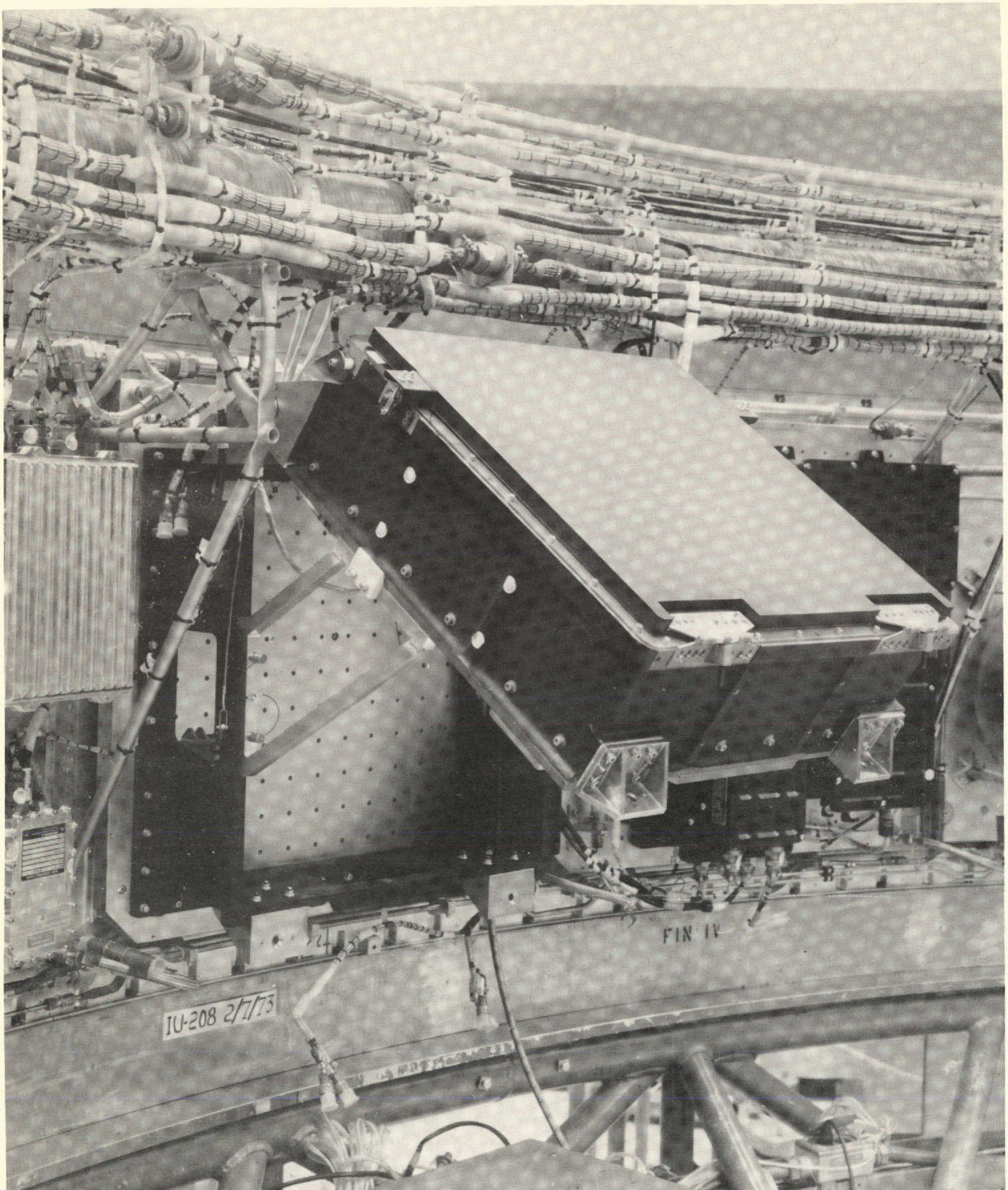


FIGURE 1-1

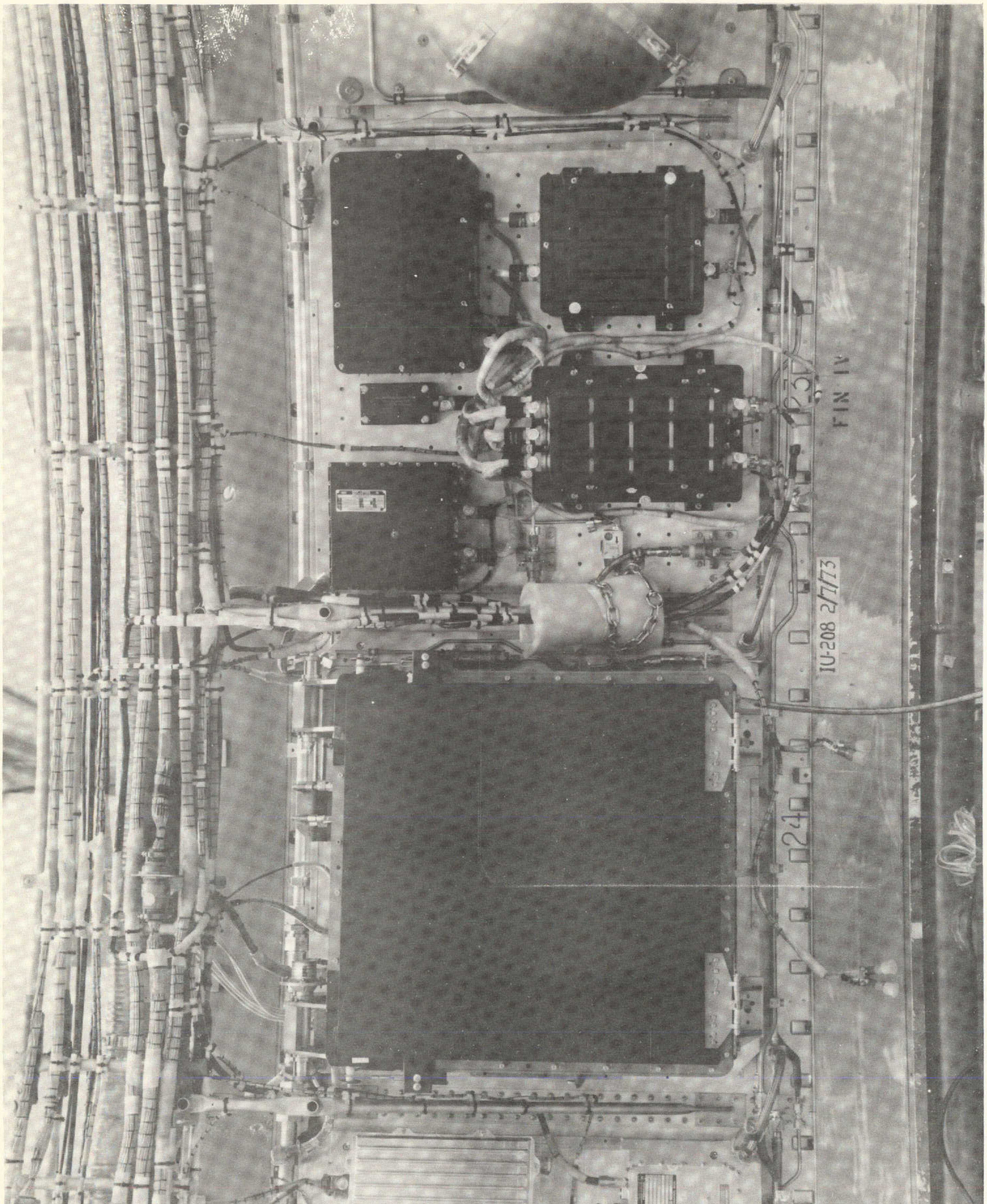


FIGURE 1-2

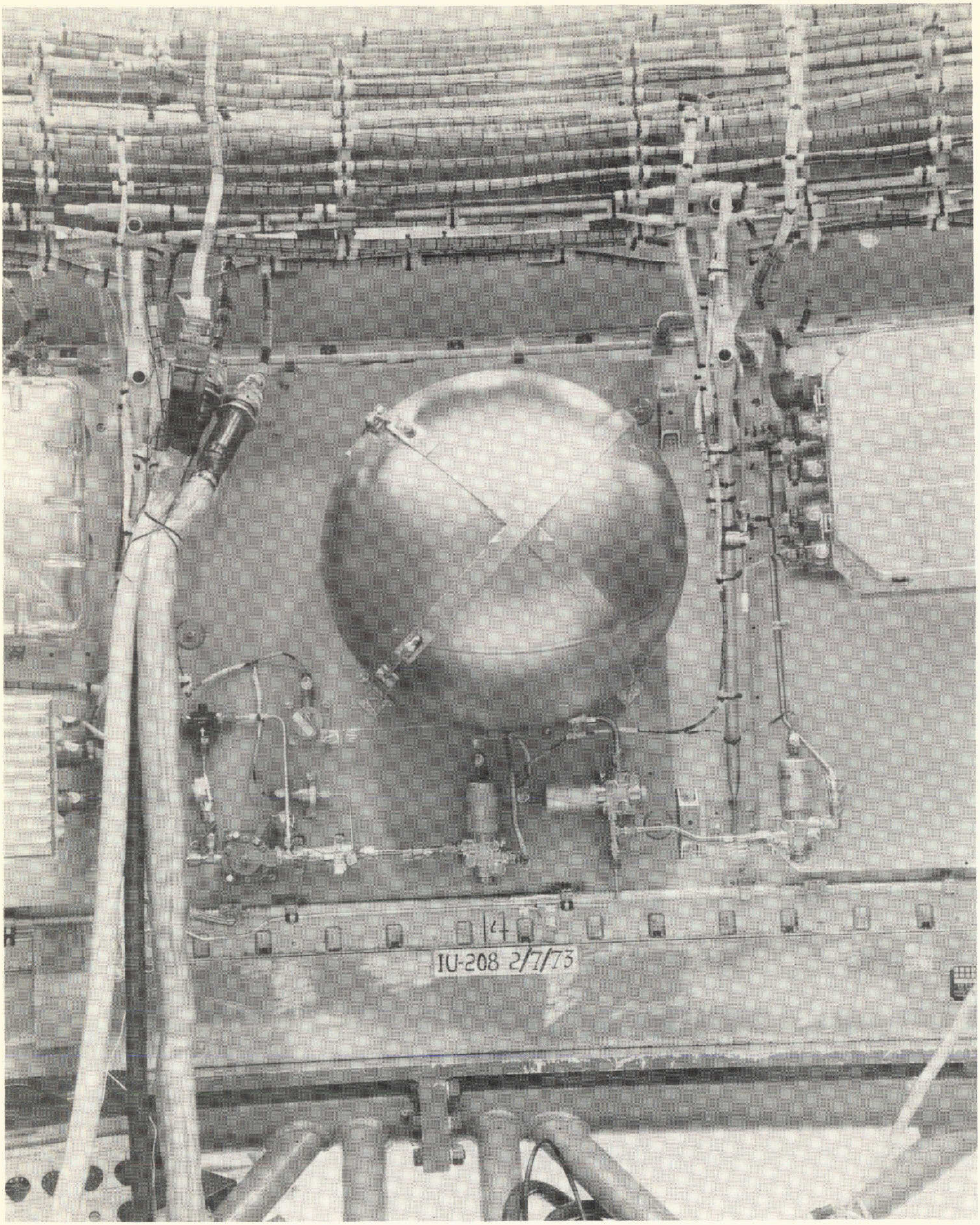


FIGURE 1-3

2.0 INTRODUCTION

The S-150 experiment was based on the design of the S-027 experiment which was designed to detect X-rays in the 2 Kev to 12 Kev energy range. The S-150 experiment was designed to detect X-rays in the range of 150 ev to 10 Kev.

The experiment mated to the Saturn Launch Vehicle Instrument Unit and operated with the I. U. through the Auxiliary Storage and Playback System (ASAP).

A block diagram of the experiment is shown in Figure 2-1. The experiment consists of a continuous flow gas counter assembly which includes the viewing counters and 13 veto counters, change amplifiers, high voltage supply and constant density gas regulator.

The viewing window associated with the counter assembly is made of ultra thin "Kimfoil" in order to allow passage of the low level X-rays. The "Kimfoil" window is characteristically leaky and necessitates the use of a constant density gas system to replace lost gas. The outputs of the charge amplifiers contained in the counter assembly are connected to variable gain buffer amplifiers which have outputs to five level discriminators. The discriminators analyze the pulse height of the received pulses, and present the quantized data to the digital data processor which conditions the data for acceptance by the I. U.

The Counter Assembly also contains counters which inhibit counts caused by cosmic rays. These veto counters are connected to charge amplifiers which have outputs connected to threshold discriminators. The outputs of the threshold discriminators are ORed together and provide an inhibit within the data processor to corresponding pulses presented via the viewing counters. The data processor also provides count information concerning the number of veto pulses received.

The S-150 experiment requires a gas supply for the counters. The gas is stored at a reservoir pressure of 1700 psig. The pressure is reduced thru a differential regulator to 30 psia, for interface with the constant density regulator contained in the counter assembly. Initial commands to control the gas originate in the IU and are applied to the experiment thru the Interface distributor contained in the experiment package. During the experiment phase of flight the gas is controlled by the constant density regulator.

A calibrate mechanism is included to expose the counter to a known radioactive source for a short time at set intervals. The command to calibrate is received from the IU thru the experiment Interface Distributor.

The experiment develops the required internal voltages thru a low voltage power supply which operates from the vehicle +28 V power bus.

The experiment contains an Analog Signal Conditioner which has the capability of conditioning twenty-five analog housekeeping measurements for presentation to the IU interface.

Two star sensor assemblies are contained in the experiment to provide location and orientation information in addition to that provided by the IU. The star sensors allows the X-ray sources being monitored to be located in space more accurately than could be done by relying on the IU location information alone. The assemblies each consist of a lens, a field defining slit, and a photomultiplier tube, a high voltage power supply, an electrometer, a buffer amplifier, and a high intensity light protection circuit. The two tubes project a field defining slit $0.1^{\circ} \times 10^{\circ}$ arranged to cross each other at 24° and each making an angle to the line of motion scribed by the sensor normal of 67.5°. The counter assembly high voltage is controlled by a circuit which monitors the counter gas pressure. The circuit disables the high voltage supply at all times the gas pressure is below a pre-determined level. A detailed description of each subsystem operation is provided in section 3 of this report.

Each subassembly is described in section and interrelated to the overall system.

Section 5 describes the environmental qualification test and test results and section 6 discusses the Ground Support Equipment used for checkout of the experiment.

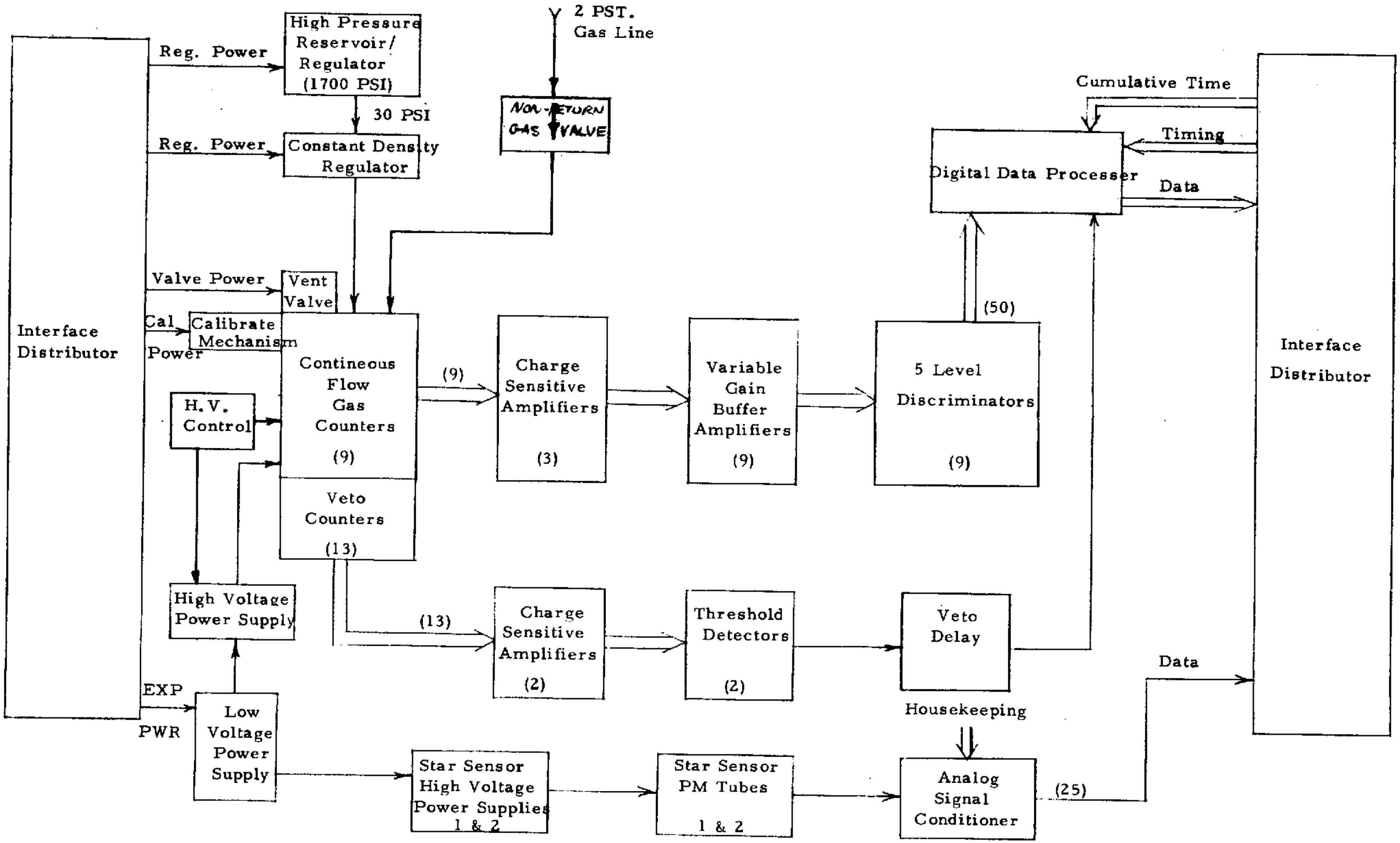


FIGURE 2-1 S-150 EXPERIMENT BLOCK DIAGRAM

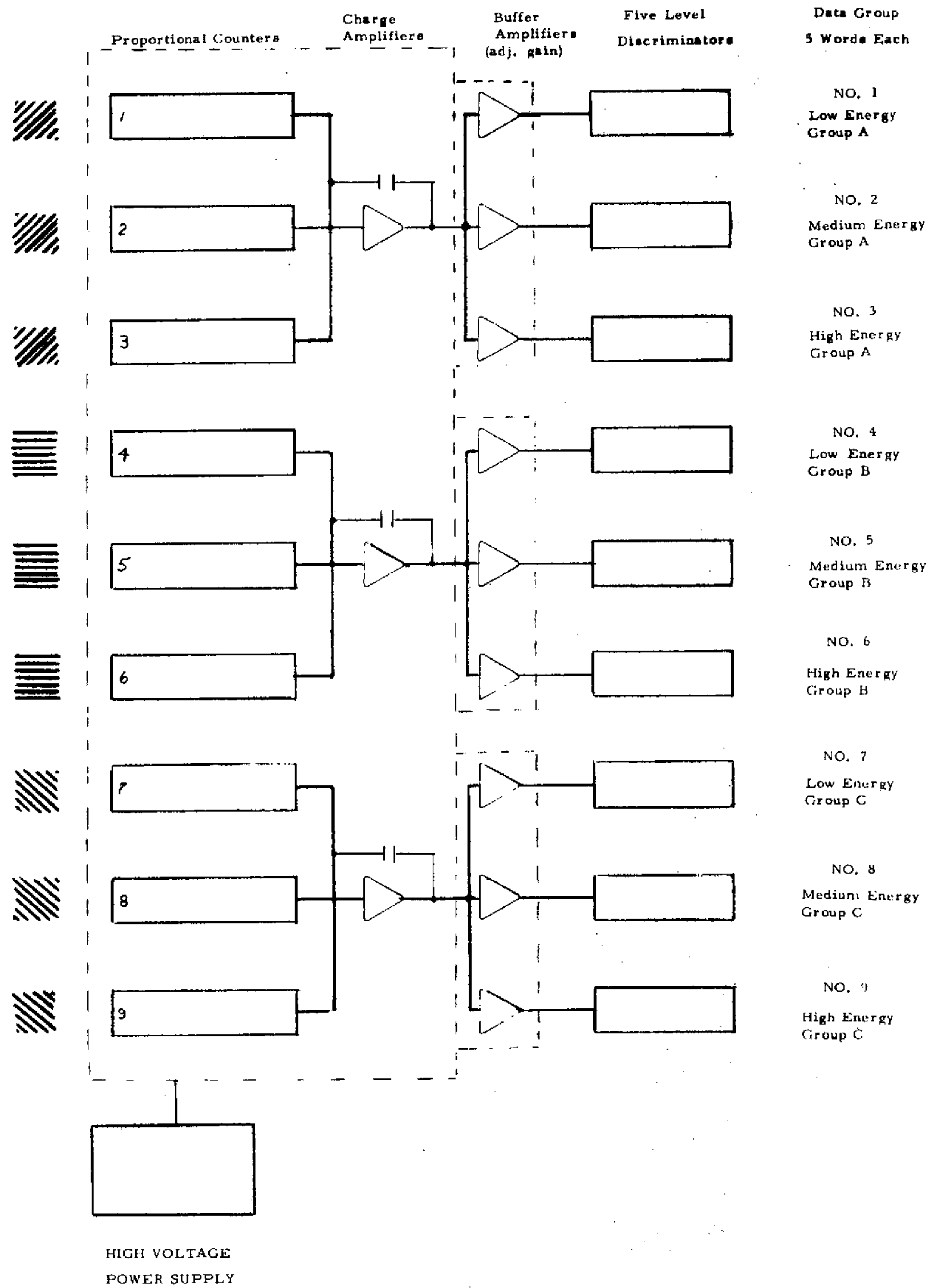
3.0 EXPERIMENT DISCUSSION

3.1 COUNTER ASSEMBLY SIGNAL DETECTION SYSTEM

The primary purpose of the S-150 experiment was to detect low energy X-rays. Due to the low penetration ability of the low energy X-rays a redesign of the signal detection system from that used on the S-027 was necessary. An ultra thin window material (Kimfoil) was used to allow penetration by the low energies. The thin window material is characteristically leaky and requires a gas flow system to replenish the escaping counter gas. The Counter Assembly was developed by the University of Wisconsin and utilized a state of the art constant density gas regulation system which compared the counter cavity gas density to a standard reference volume of known density. The Counter Assembly consisted of nine active counter channels and 13 veto channels. Each channel was isolated from the adjacent channels by electro statically charged partition wiring. The channels were functionally grouped together for processing in that each of the three groups counters, three 90^{o} counters, three -45^{o} counters and three $+45^{o}$ counters - shared a common charge amplifier.

The complete Counter Assembly consisted of the mechanical collimators, the gas filled sensor cavity with anode detection wires, the primary charge amplifiers, the high voltage supply and the gas regulation system.

P-10 (90% Argon and 10% methane) X-ray counting gas was utilized in the detection system. Figure 3-1 shows a block diagram of the Detector System. As X-ray energies were encountered, the P-10 gas in conjunction with the high voltage anode wire would produce a signal which was AC coupled from the Anode wires to the primary change amplifiers. The amplitude of the output is directly proportional to the energy of the received X-ray.



DETECTOR SYSTEMS

FIGURE 3-1

The primary change amplifiers were connected to Buffer amplifiers. Both the primary charge amplifiers and Buffer amplifiers had adjustable gain so that the overall system gas could be accurately set to provide the proper pulse heights to the 5 level descriminators for analysis into pulse height range.

3.2 DIGITAL DATA PROCESSING

The digital data processing is accomplished in the Digital Data Processor. The processing is done in 12 groups. The first 10 groups are used to tabulate X-ray counts the remaining two groups provide such data as Veto counts, discrete bit words. Timing data, sync code and information about odd angle events occurring prior to Veto.

Each group consists of five 10 bit words. The first nine groups tabulate the data from the nine proportional counters. The tenth group tabulates events occurring in group 4, at a delayed time which effectively provides fifty new bits of information, but also provides a backup check of the data in group 4. Words 1 and 2 of group 11 form a 19 Bit Veto pulse counter which counts the number of X-rays of greater energy level than those to be analyzed by the sensor.

Words 3 and 4 of group 11 are divided into 5 separate words of 4 bits each. Words one and two of this group are used to detect Horizontal Cosmic rays. Word 3 is used to detect long horizontal rays. Word 4 detects Vertical Cosmic rays. Word 5 tabulates the number of X-ray events greater than 15 Kev in data group 6 prior to Veto.

Word 5 of data group 11 consists of 10 discrete bit words which are used for diagnosis. Information concerning Cal. Rod Status, solenoid status monitor and electrical regulator operation is contained in these bits. Data group 12 word 1 and 2 contain cumulative time data and word 3, 4, and 5 contain sync code information.

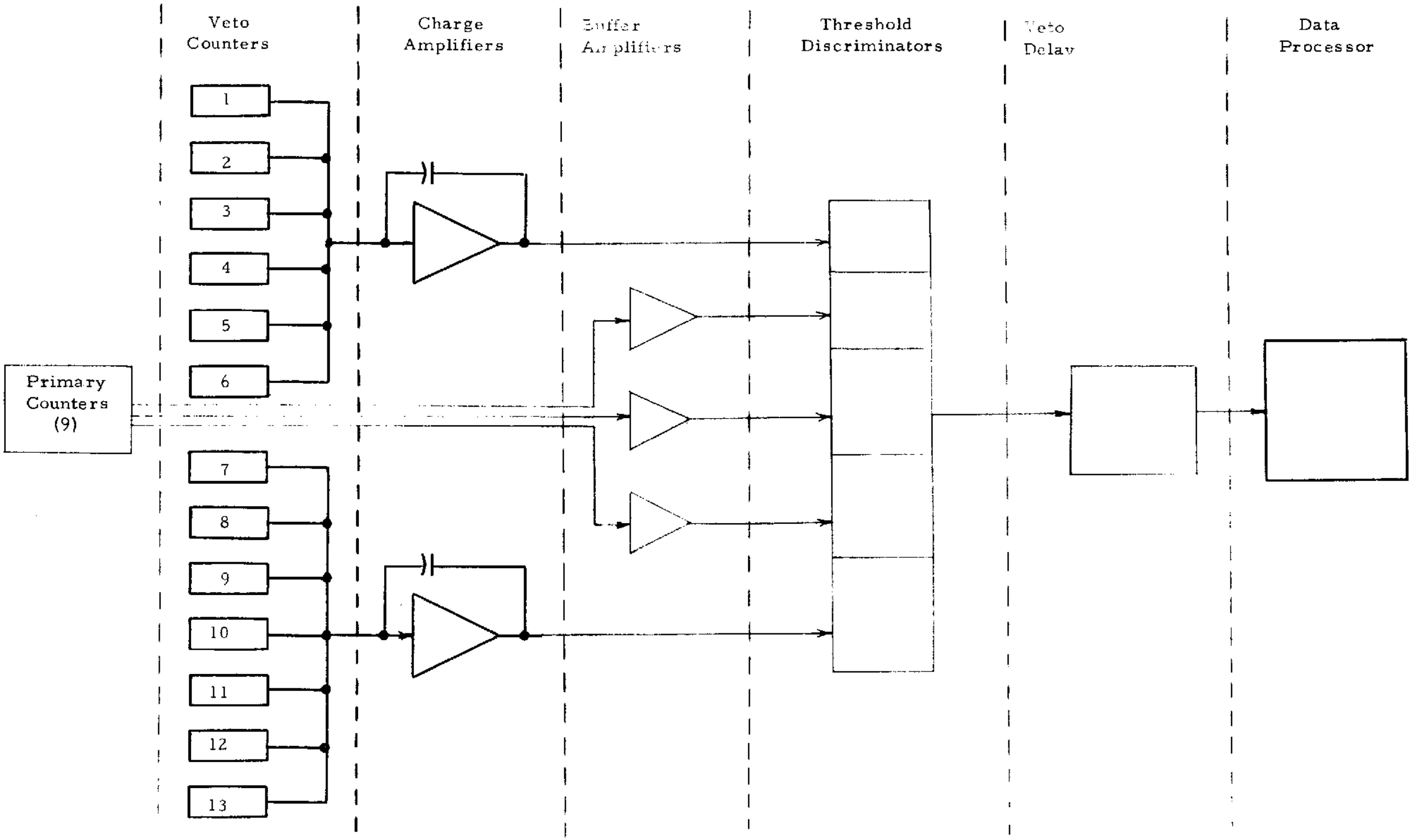
3.3 VETO SYSTEM

The veto system for the S-150 is considerably less complex than for the S-027. As shown in Figure 3.3-1, thirteen veto counters are arranged around and under the Nine Active Counters. The 13 veto counters were ORed to a change amplifier set to produce a veto signal to the threshold discriminator as energies sufficient to penetrate the counters were encountered. In addition, to the veto counters other veto pulses were obtained from the low gain Buffer Amplifier Channels thru a resistive divider to allow for vetoing energies at a set level greater than 10 Kev. The setup provided 5 separate veto inputs signals to the threshold discriminator. The adjustable levels on the threshold discriminator were set to produce a single discriminator output pulse if any of the input levels were high enough to require vetoing. The output of the threshold discriminator is connected to a veto delay circuit which delays the veto pulse to the data processor so that the veto or inhibit to the processor will coincide with the actual data to be vetoed at the data processor.

3.4 STAR SENSOR SYSTEM

The same star sensor system is used on both the S-027 and S-150 experiment.

Each assembly consists of a lens, a field defining slit, and photomultiplier tube, a high voltage power supply, an electrometer, a buffer amplifier and a high intensity light protection circuit. The two tubes project a field defining slit $0.1^{\circ} \times 10^{\circ}$ arranged to cross each other at 24° and each making an angle to the line of motion scribed by the sensor normal of 67.5°. A



BLOCK DIAGRAM

VETO CIRCUITRY

Figure 3.3-1

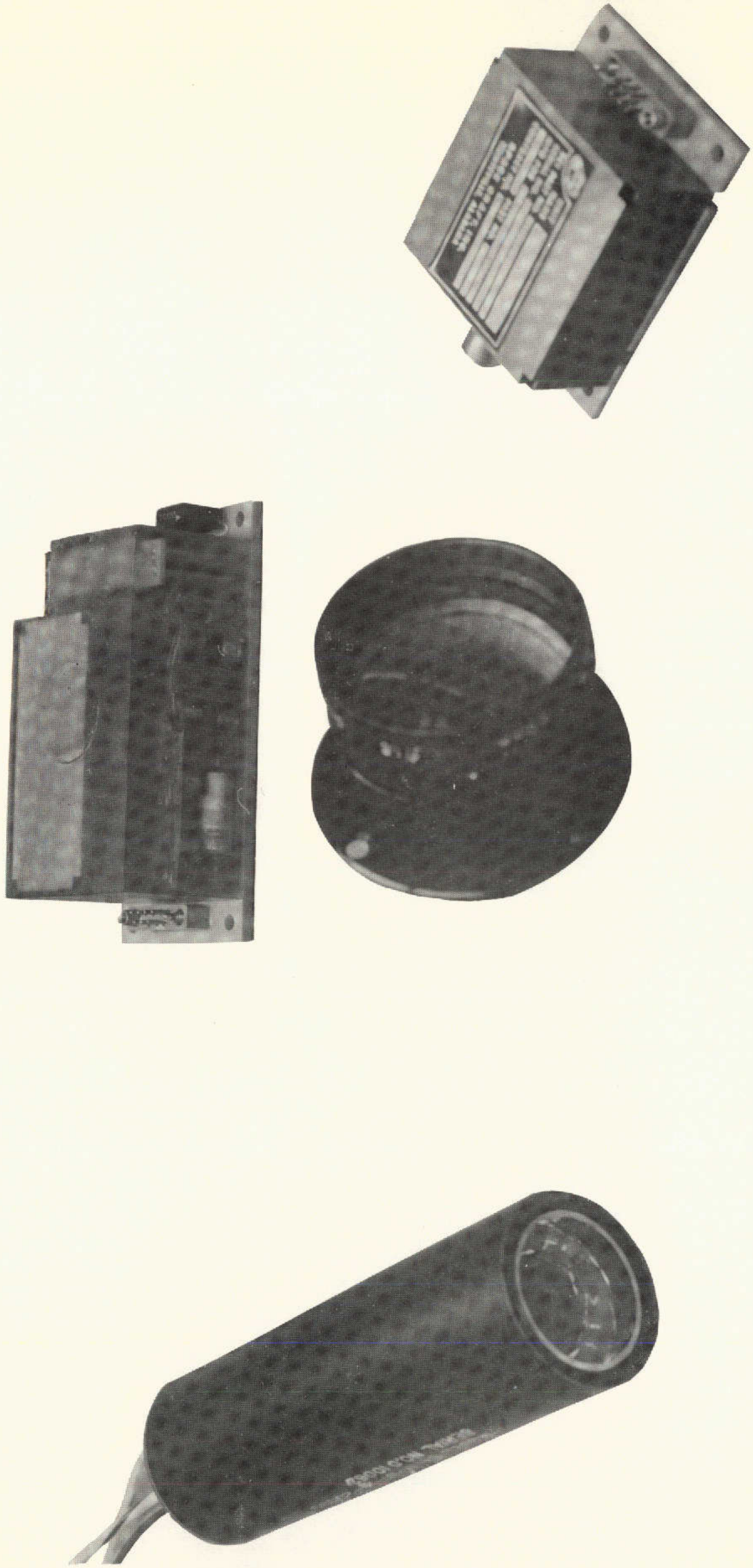


FIGURE 3.4-1

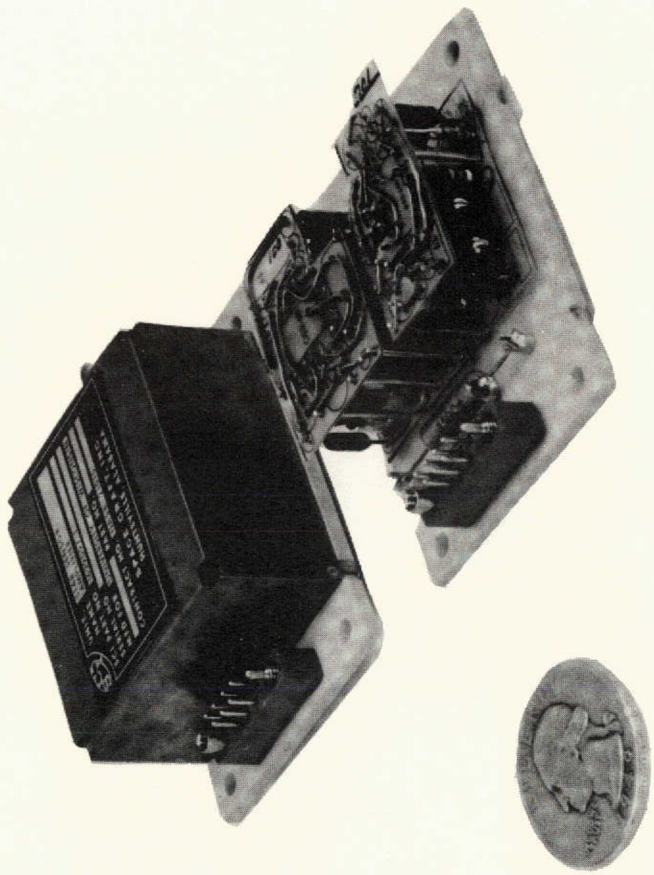


FIGURE 3.4-2

component photo of the star sensor electronics is shown in figure 3.4-1. The high voltage supply produces accelerating potentials for the dynode assemblies in the phototube. Constant power is provided by the supply thru the tubes resistive divider, unless the tube is operated into saturation from excessive light intensitites incident in the star field.

The output from the phototube is conditioned and amplified by the electrometer and buffer amplifier contained in the amplifier assembly, figure 3.4-2. A high intensity light protection circuit is included to reduce the voltage of the high voltage supply and thereby the gain of the phototube when intense light is in the field of view.

3.5 CALIBRATION MECHANISM

A single Fe_{55} radioactive source calibration rod was used on the S-150 experiment to verify the calibration accuracy. The rod was extended by a solenoid to expose the counters to the Fe_{55} source for 5 seconds at 30 minute intervals during the experiments active life. The in-flight calibration checks provided a high confidence level for data accuracy since every thirty minutes a block of reference data was recorded to allow checking the gain of the system.

3.6 GAS SYSTEM

The S-150 gas system was configured to allow to gas inputs to the experiment. One input was used for holding a deadhead positive pressure of approximately 2 psia to the counter window up until lift off. At lift off the pressure was reduced by allowing the counter gas to escape through the exhaust valve.

After orbit was achieved the experiment gas supply was energized and the constant density gas system filled the counter and provided a constant gas supply to the counter assembly.

The constant density regulator electronics, which effectively is a gas density comparator, was used to compare the counter gas density with a reference volume of know density and then providing an appropriate command to equalize the cavity density to that of the reference. The repetitive rate of the regulation system after the initial filling of the gas cavity was a function of the gask leak rate. The sensor assembly regulator system was capable of supplying a constant density gas supply to the counter even if a large gas escape rate such as would result from the exhaust vent valve hanging in an open position or a large puncture in the thin Kemfil window.

A block diagram of the S-150 gas system is shown in Figure 3.6-1.

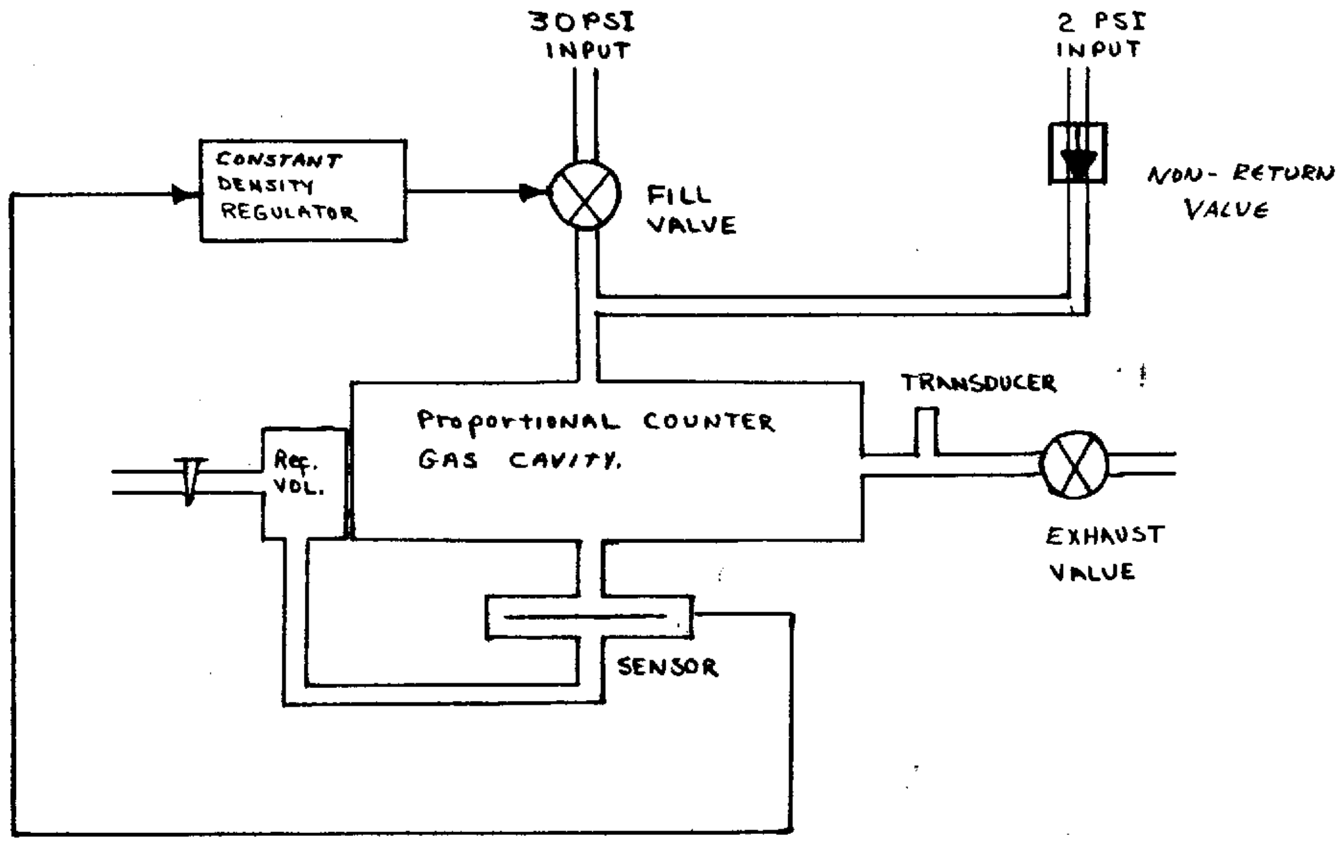


FIGURE 3.6-1

S-150 GAS SYSTEM

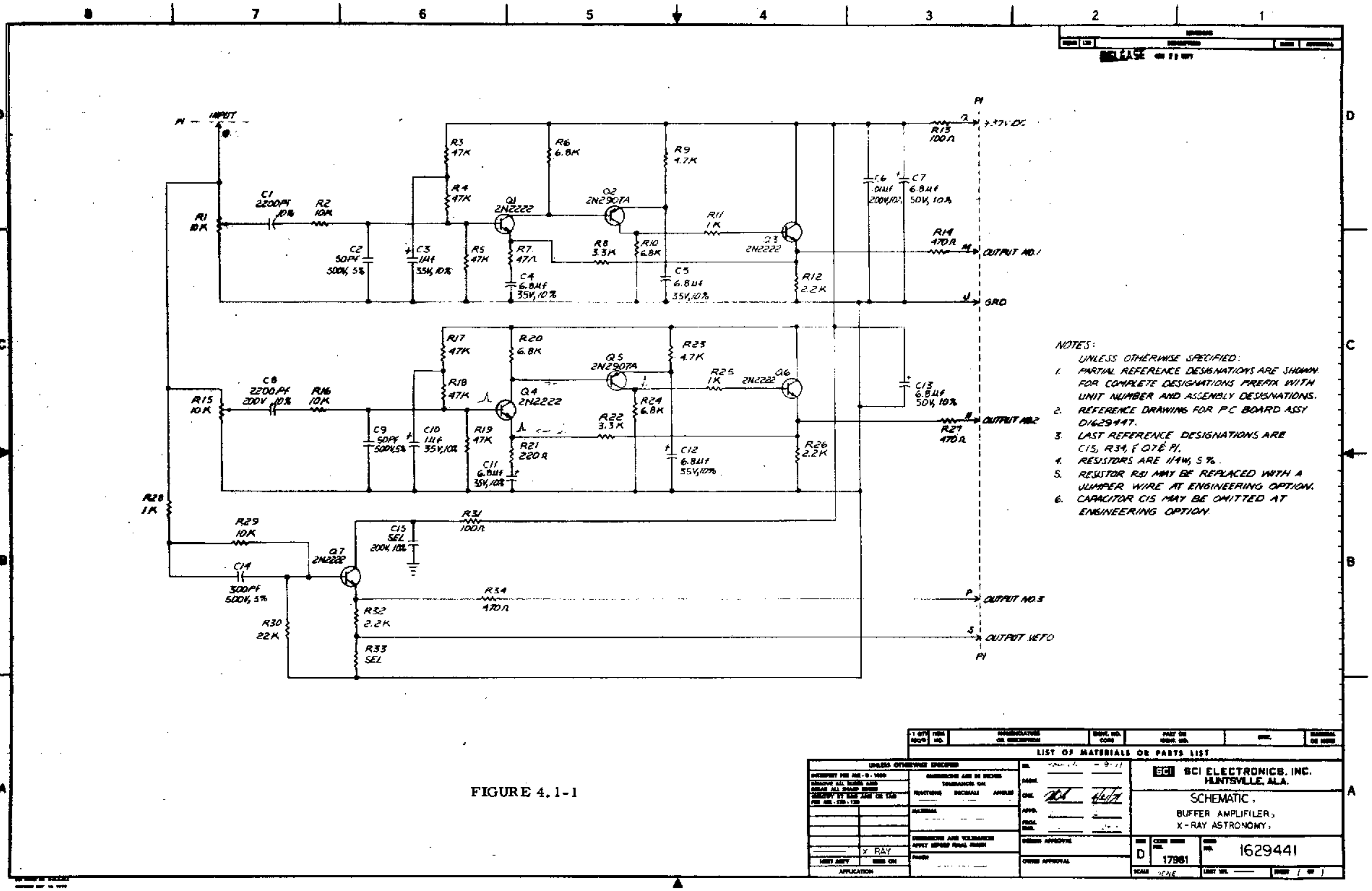
4.1 BUFFER AMPLIFIERS

A schematic of the S-150 Buffer Amplifier is shown in figure 4.1-1.

There are three separate amplifiers on each Buffer Amplifier Assembly.

Two of the amplifiers have adjustable gains and the third is a voltage follower with a resistive divider which provides an attenuated output corresponding to large pulses, to produce veto pulses to the threshold discriminators.

The output from the primary charge amplifier is connected commonly to each of the three amplifiers contained on each buffer amplifier board. The gain is adjusted in the buffers as required to provide the proper pulse height for the 5 level trigger points.



INPUT
+ 32V DC
OUTPUT NO. 1
GRD
OUTPUT NO. 2
OUTPUT NO. 3
OUTPUT VETO
NOTES:
UNLESS OTHERWISE SPECIFIED:
1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATIONS PREFIX WITH UNIT NUMBER AND ASSEMBLY DESIGNATIONS.
2. REFERENCE DRAWING FOR P.C BOARD ASSY 01629447.
3. LAST REFERENCE DESIGNATIONS ARE C15, R34, & Q7 & P1.
4. RESISTORS ARE 1/4W, 5%.
5. RESISTOR R31 MAY BE REPLACED WITH A JUMPER WIRE AT ENGINEERING OPTION.
6. CAPACITOR C15 MAY BE OMITTED AT ENGINEERING OPTION.
LIST OF MATERIALS OR PARTS LIST
SCI ELECTRONICS, INC.
HUNTSVILLE, ALA.
SCHEMATIC,
BUFFER AMPLIFILER,
X-RAY ASTRONOMY,
X RAY
D
17981
1629441

FIGURE 4.1-1

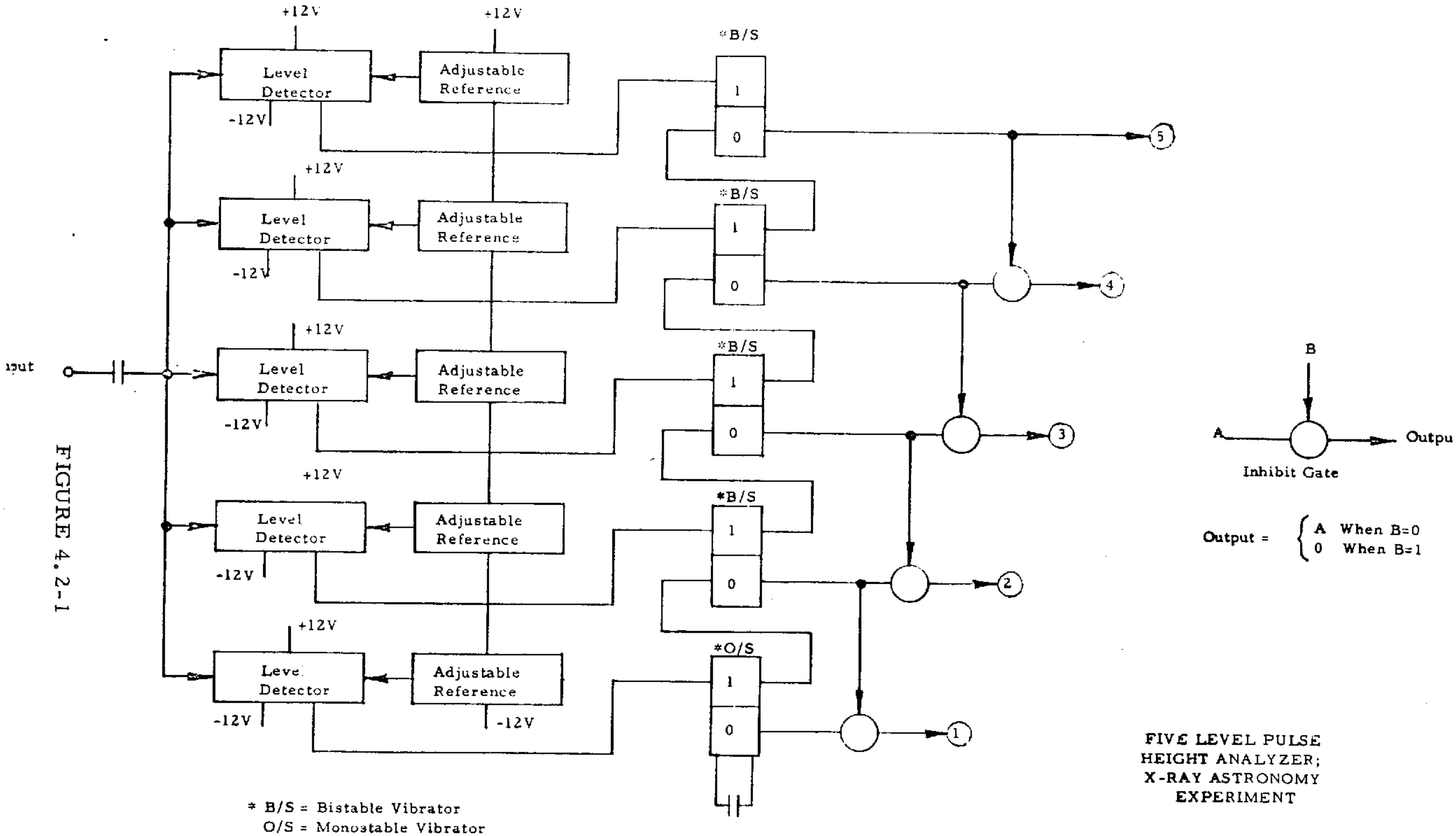
4.2 FIVE LEVEL DISCRIMINATOR

The same Five Level Discriminators are used in both the S-150 and S-027 experiments. A block diagram of the Five Level Discriminator is shown in figure 4.2-1 and a schematic is shown in figure 4.2-2.

The input is obtained from the signal amplifier output. When an input is received, the signal triggers a one shot circuit which enables the analyzer and provides blanking for the duration of the one-shot pulse.

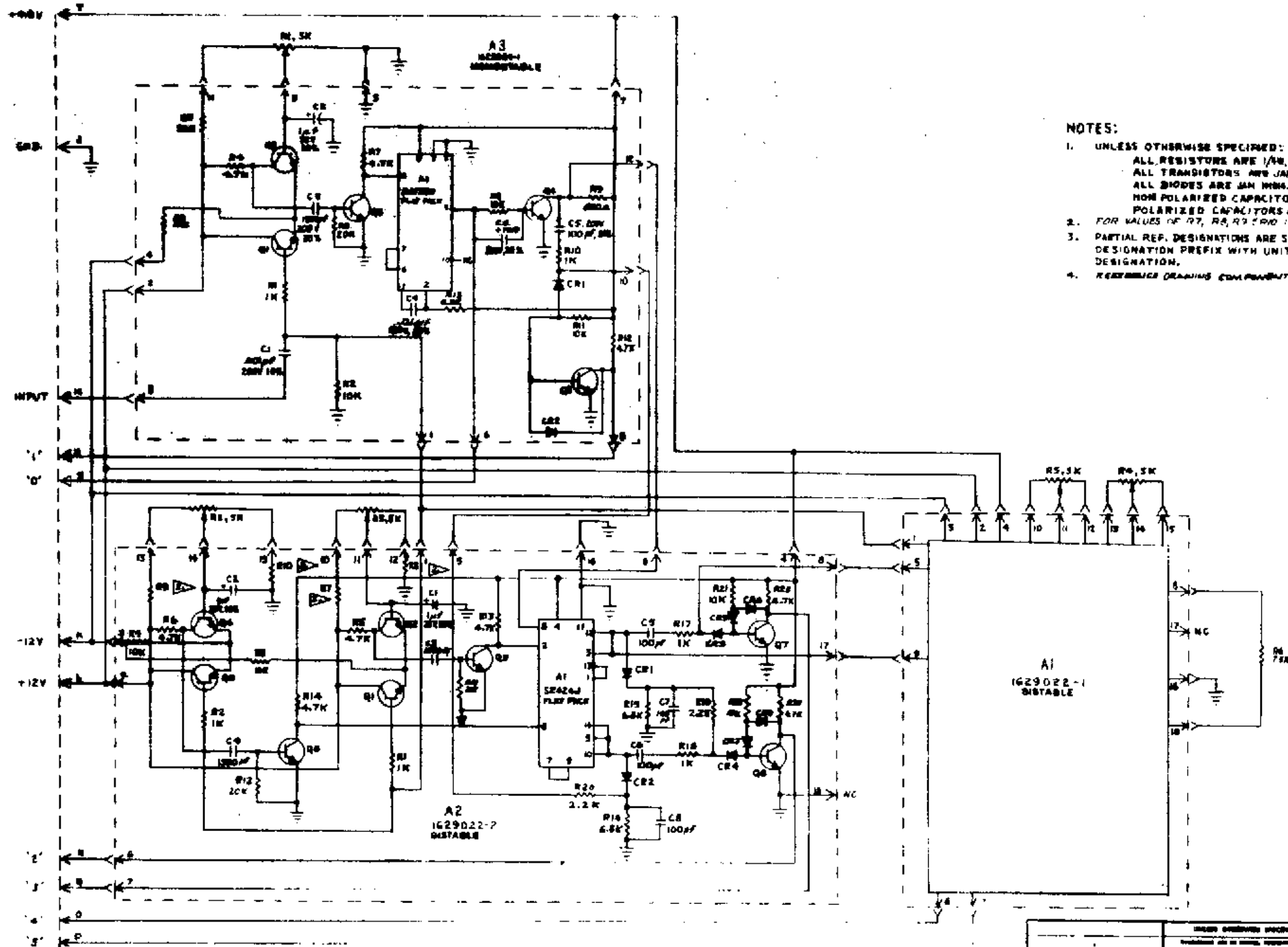
The circuit is designed so that an output is obtained from only the highest level that the input pulse is capable of triggering. Each level of the five level is adjustable over a selected range and each level is interconnected to inhibit the output from the lower levels. The fifth level is open-ended in that all pulses above that threshold level appear at the output.

A photograph of the Five Level Discriminators in their stacked configuration is shown in figure 4.2-3.



FIVE LEVEL PULSE HEIGHT ANALYZER; X-RAY ASTRONOMY EXPERIMENT

FIGURE 4.2-1



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE 1/4W, 5%
   ALL TRANSISTORS ARE JAN2N2222.
   ALL DIODES ARE JAN 1N914.
   NON POLARIZED CAPACITORS ARE 200V 20%
   POLARIZED CAPACITORS ARE 150D SPRAGUE.
2. FOR VALUES OF R7, R8, R9 & R10 IN MODULES A1 AND A2 SEE TABLE.
3. PARTIAL REF. DESIGNATIONS ARE SHOWN, FOR COMPLETE DESIGNATION PREFIX WITH UNIT NO. AND ASSEMBLY DESIGNATION.
4. REFERENCE DRAWING COMPONENT ASS'Y D-1629020, (DIAGRAMS.

RESISTOR REF DES	1629022-1	1629022-2
	A1	A2
R7	39K	30K
R8	10K	5.1K
R9	39 K	33K
R10	6.8K	1.6K

FIGURE 4.2-2

LIST OF MATERIALS

SCHEMATIC,
FIVE LEVEL
DISCRIMINATOR,
X-RAY ASTRONOMY

SPACE CRAFT Inc.
HUNTSVILLE, ALA.

D 1629019

x-ray

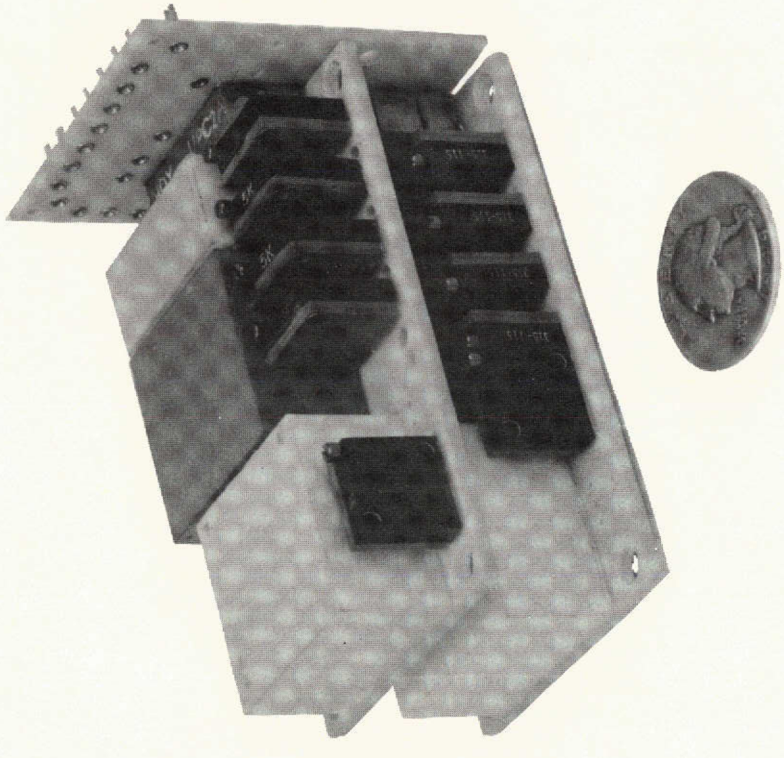
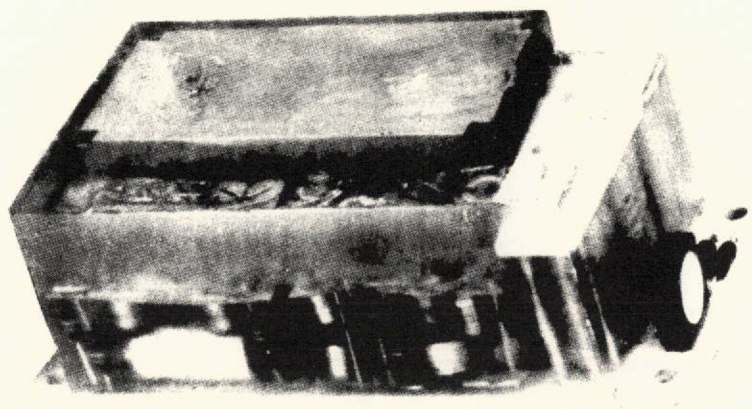


FIGURE 4.2-3

4.3 HIGH VOLTAGE POWER SUPPLIES

The same high voltage supplies are used in both the S-150 and S-027 experiments. A package outline is shown in figure 4.3-1. Each supply operates from an unregulated input which is regulated by a series transistor internal to the high voltage supply. The regulated output is stepped up in the converter module by a 1:25 ratio. The final output is obtained from a voltage multiplier circuit. The output is sampled and compared to a reference voltage in a comparison amplifier which controls the series element.

The basic circuit is common to all the high voltage supplies. A schematic of the -2500 vdc supply is shown in Figure 4.3-2. The number of voltage multiplier stages and the polarity of the diodes in the multiplier are changed to produce the required output voltage.



PACKAGING OF H.V. POWER SUPPLIES

FIGURE 4.3-1

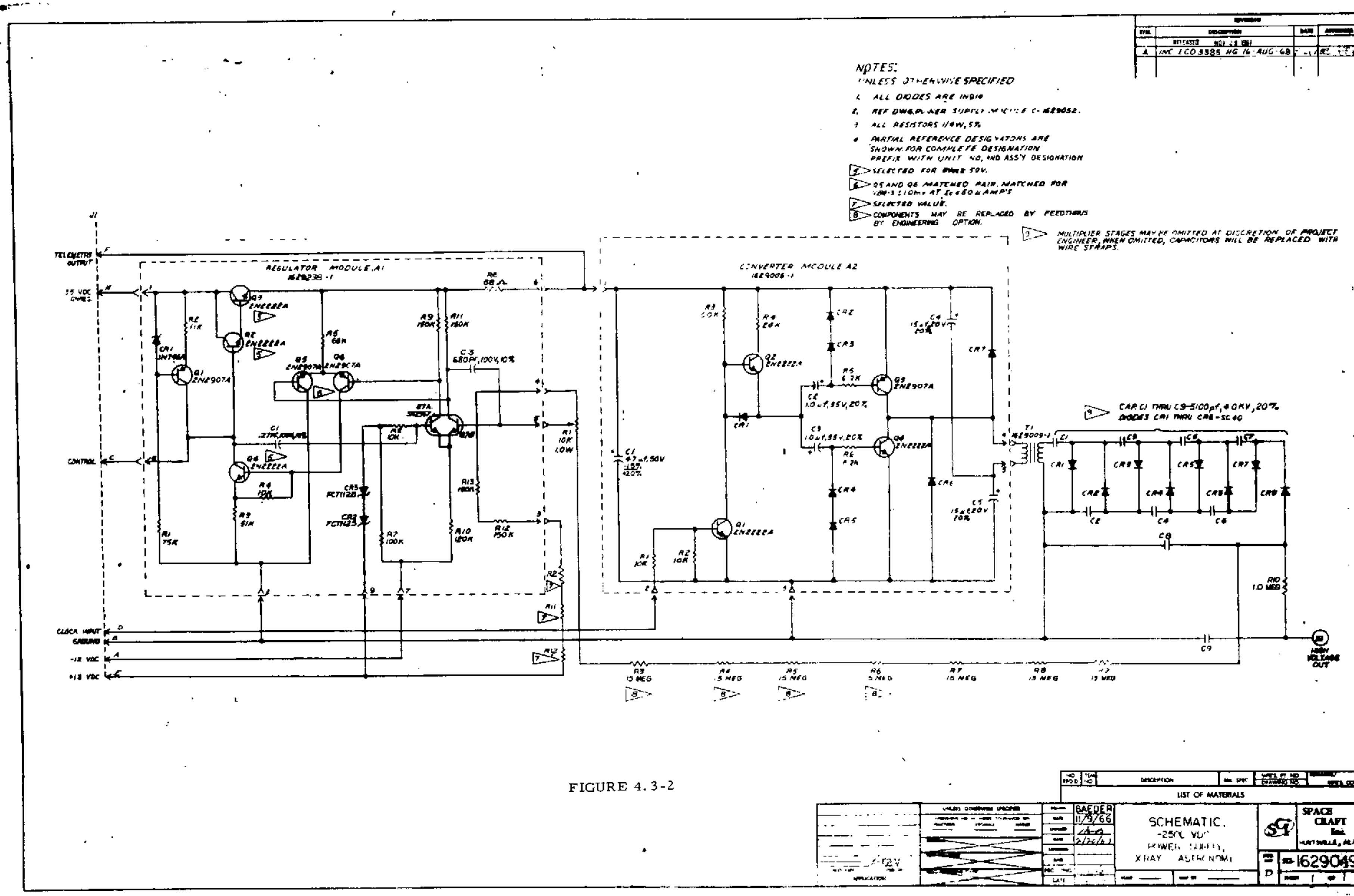

NOTES:
UNLESS OTHERWISE SPECIFIED
REGULATOR MODULE, A1
CONVERTER MODULE A2
SCHEMATIC, -2500 VDC POWER SUPPLY, XRAY ASTRONOMY
1629049

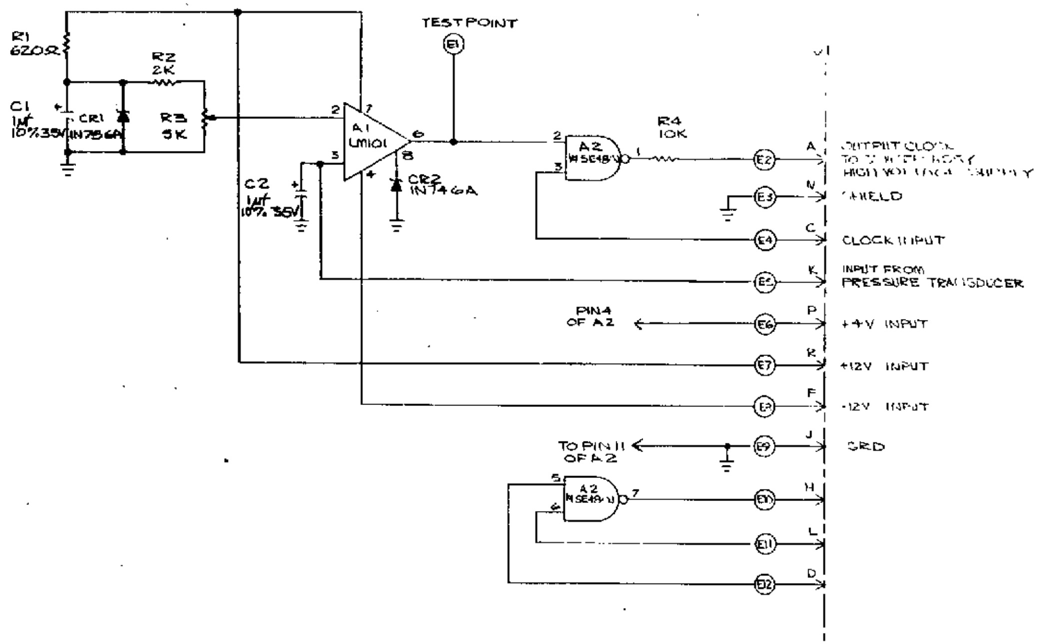
FIGURE 4.3-2

4.4 HIGH VOLTAGE CONTROL CIRCUIT

A schematic of the High Voltage Control Circuit is shown in Figure 4.4-1. The high voltage control circuit is used to disable the high voltage when the counter pressure is below a preset level. The pressure threshold level is adjustable over a wide range. The circuit is basically a comparator and gate. A reference voltage is set corresponding to the desired operating pressure. When the input voltage corresponding to the operating pressure reaches the set level the comparator switches, enabling the gate to pass the clock signal to the high voltage supply.

At any time the pressure falls below the set level the high voltage is turned off by removal of the clock. The circuit operates automatically with counter pressure.

RELEASE



NOTES:

UNLESS OTHERWISE SPECIFIED.

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN FOR COMPLETE DESIGNATIONS PREFIX WITH UNIT NUMBER AND ASSEMBLY DESIGNATIONS

2. LAST REFERENCE DESIGNATIONS ARE, R4, C2, CR2, A2. E12

3. RESISTOR ARE, 1/4 W, 5%

LIST OF MATERIALS OR PARTS LIST

SCI ELECTRONICS, INC.
HUNTSVILLE, ALA.

SCHEMATIC,
HIGH VOLTAGE CONTROL CIRCUIT
X RAY ASTRONOMY

D | 17881 | 1629455

FIGURE 4.4-1

4.5 VETO DELAY CIRCUIT

A schematic of the Veto Delay Circuit is shown in Figure 4.5-1. The veto delay circuit is used to produce a pulse to inhibit the data processor at a time coinciding with the arrival of real data which is of greater energy than that to be analyzed by the experiment and which is to be inhibited at the data processor. The circuit consists of two paralleled monostable multi-vibrators anded together to form a Veto Delay Pulse capable of inhibiting the count of cosmic rays from the data in the energy range of interest.

The input to the circuit is obtained from the veto threshold discriminator.

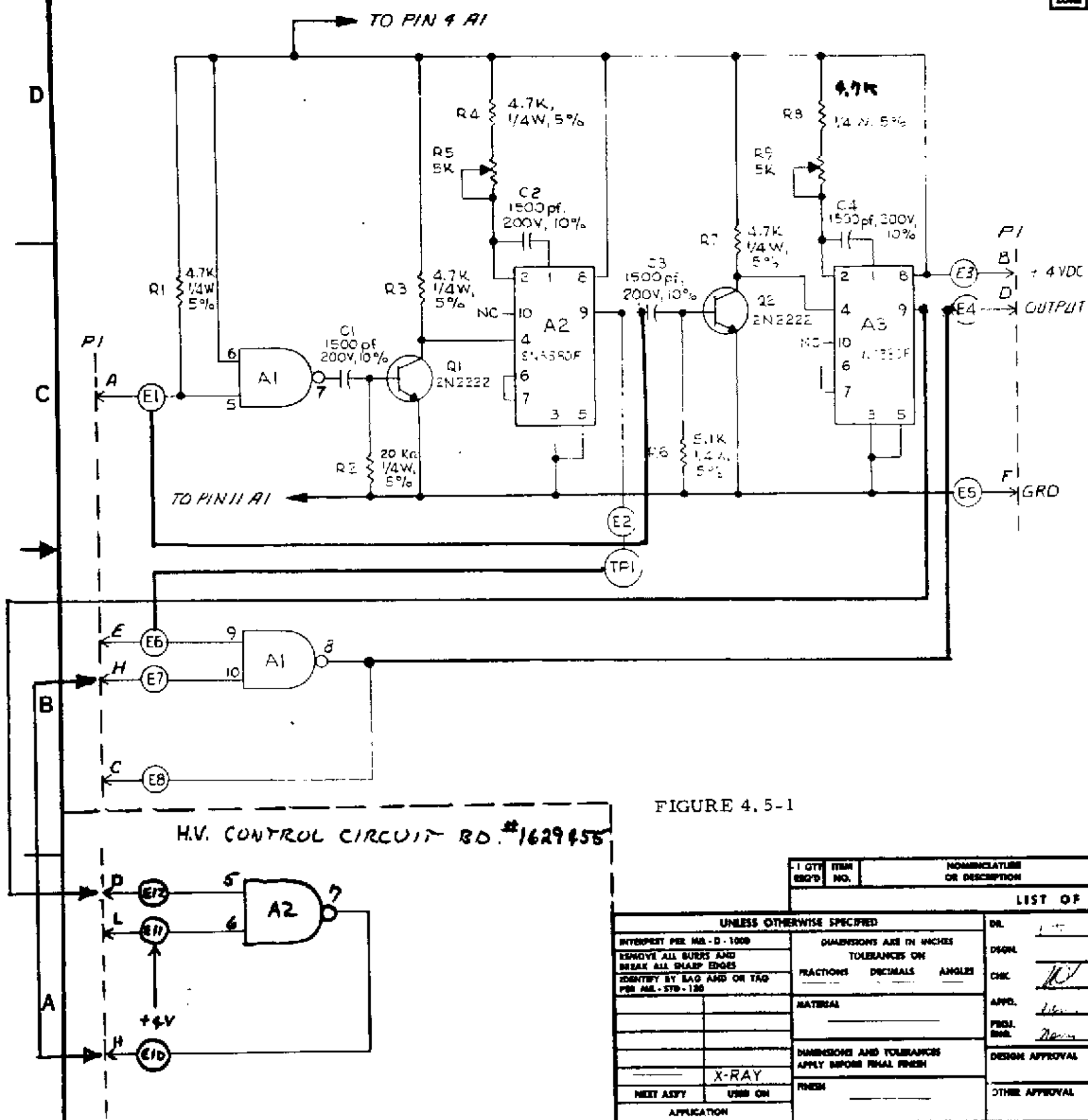


FIGURE 4.5-1

NOTES:

UNLESS OTHERWISE SPECIFIED:

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATIONS PREFIX WITH UNIT NUMBER AND ASSEMBLY DESIGNATIONS.
2. REFERENCE DRAWING FOR P.C. BOARD ASS'Y 1629453
3. LAST REFERENCE DESIGNATIONS ARE A3,C4,R9,Q2
4. FOR P.C. BOARD CIRCUIT INTERCONNECT SEE INTERCONNECTION LIST 1629445.
5. EACH LOGIC SYMBOL REPRESENTS A CIRCUIT FUNCTION WITHIN EACH INTEGRATED CIRCUIT.

REVISIONS

RELEASE JUN 24 1971

LIST OF MATERIALS OR PARTS LIST

SCI ELECTRONICS, INC.
HUNTSVILLE, ALA.

SCHEMATIC
S-150 VETO DELAY CIRCUIT

SIZE C | CODE IDENT NO. 17981 | DWG NO. 1629448

SCALE | UNIT WT. | SHEET 1 OF 1

X-RAY

4.6 THRESHOLD DISCRIMINATOR

The same Threshold Discriminator is used on both the S-150 and S-027 experiments. Figure 4.6-1 is a photograph of theThreshold Discriminator Assembly. A schematic of the Threshold Discriminator is shown in figure 4.6-2. There are six identical circuit modules on the board which are ORed together to produce a single output signal. The assembly will accept six separate inputs and produce an output pulse with an input signal on one or more of the inputs. Each of the modules has an adjustable threshold level over a selected range. Each module consists of an adjustable comparator with two one-shot modules connected in series to produce a blanking pulse.

4.7 ANALOG SIGNAL CONDITIONER

The same Analog Signal Conditioner is used for both the S-150 and S-027 experiments. The analog signal conditioner consists of two printed circuit boards and has twenty five channel capability for conditioning data for acceptance by the analyzers. In addition to the twenty five active channels, there are five supplemental channels provided to monitor temperatures in certain portions of the experiment by the Ground Support Equipment during experiment checkout.

Each channel is conditioned to produce an output from zero to five volts d.c. with a source impedance of 10,000 ohms maximum. Schematics of the analog boards are shown in figure 4.7-1 and 4.7-2.

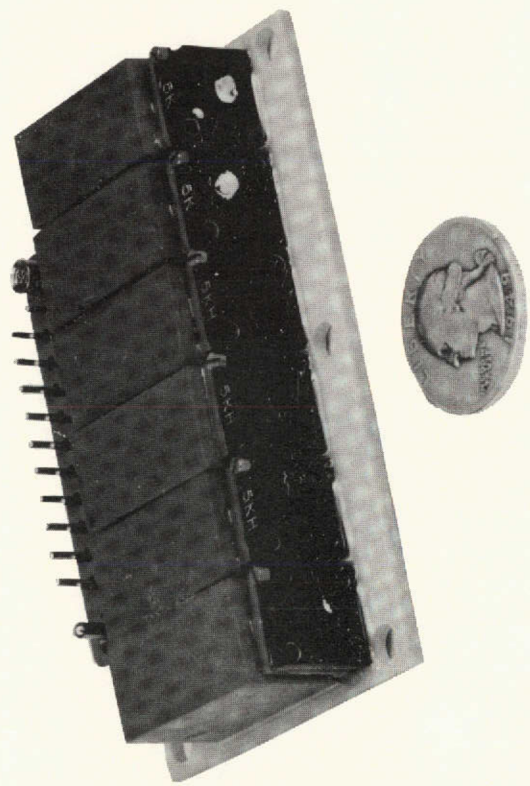


FIGURE 4.6-1

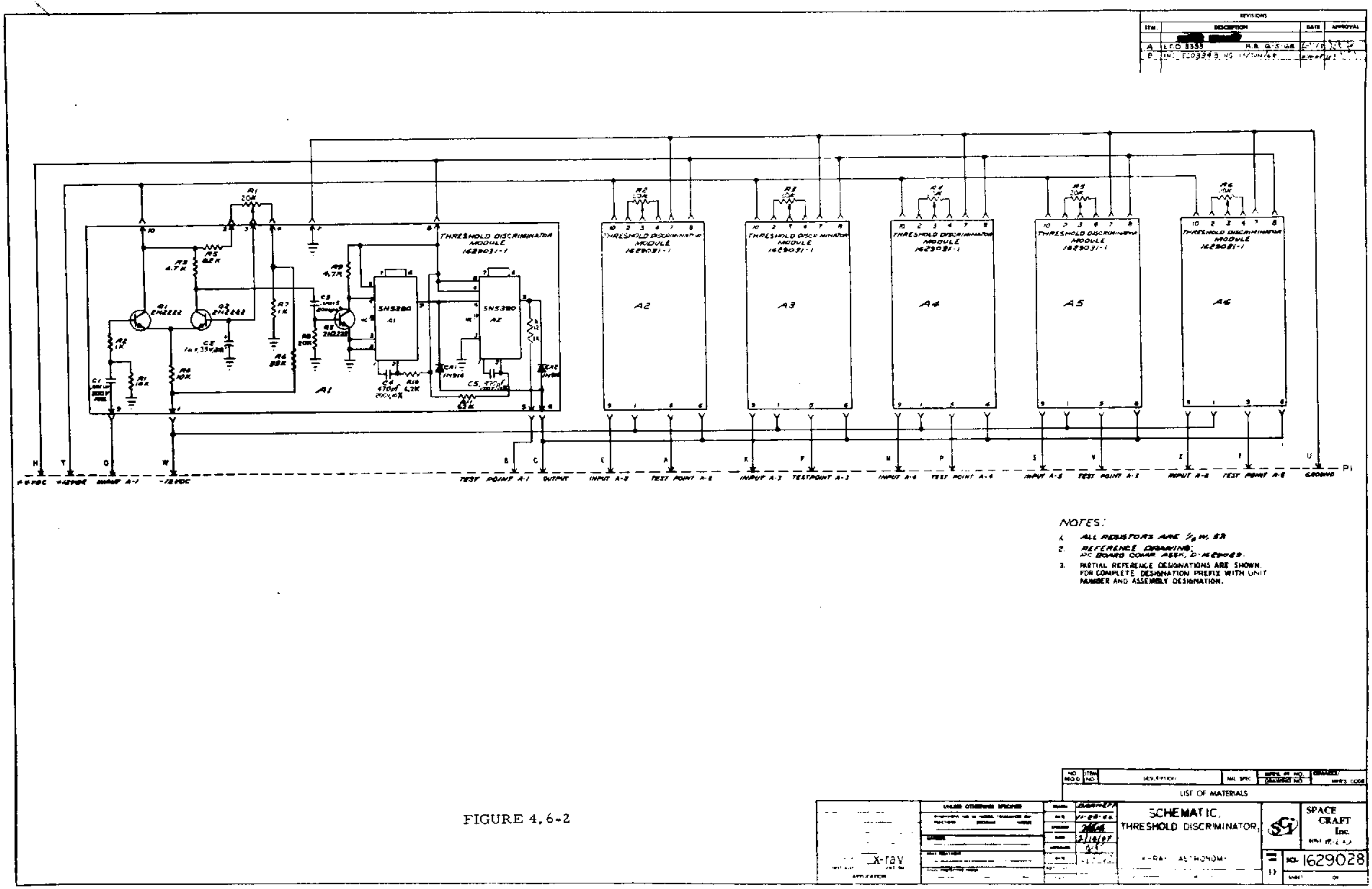
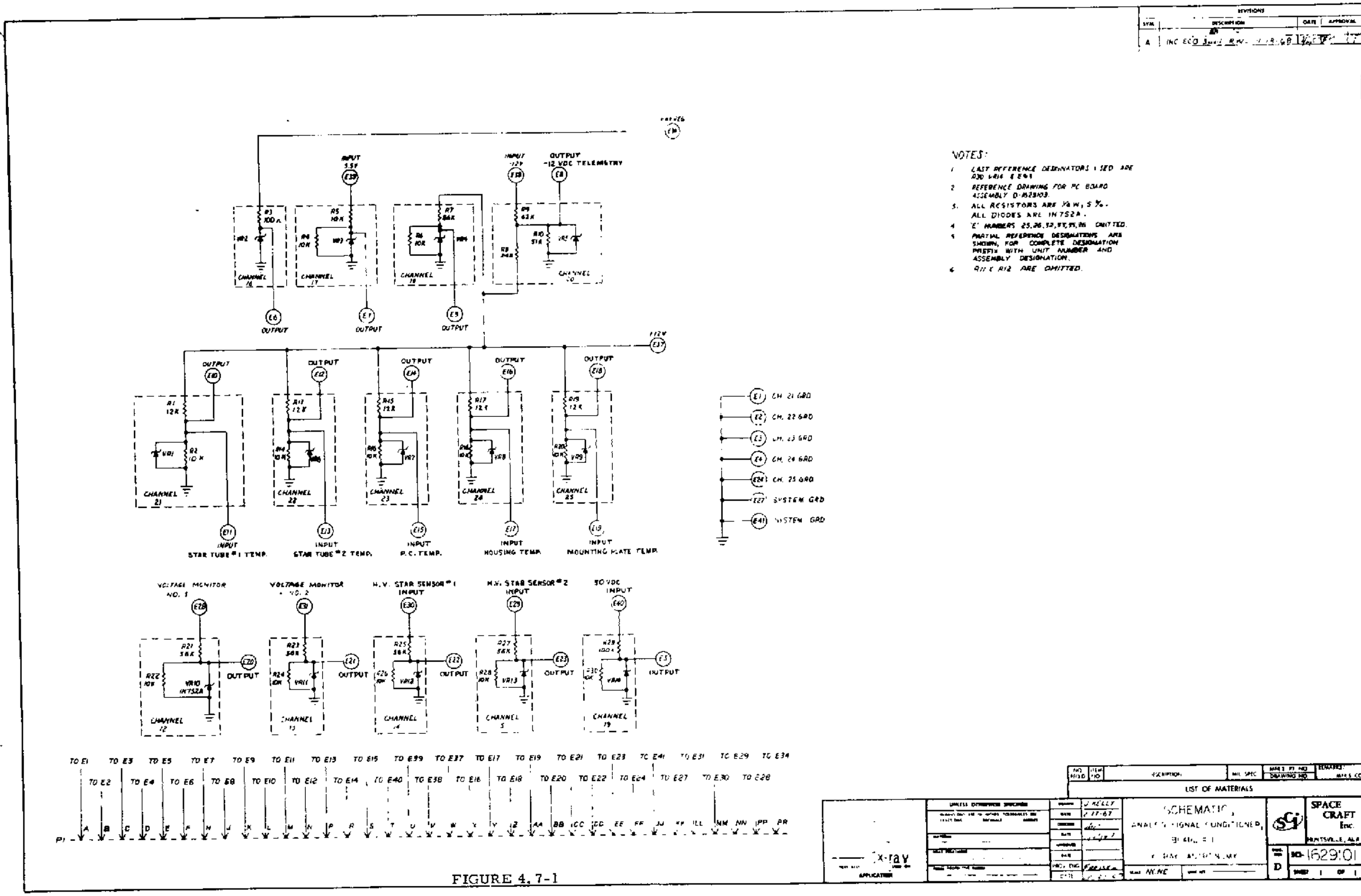

THRESHOLD DISCRIMINATOR MODULE 1629031-1
SN5280
A1
A2
A3
A4
A5
A6
TEST POINT A-1
OUTPUT
INPUT A-2
TEST POINT A-2
INPUT A-3
TEST POINT A-3
INPUT A-4
TEST POINT A-4
INPUT A-5
TEST POINT A-5
INPUT A-6
TEST POINT A-6
GROUND
NOTES:
1. ALL RESISTORS ARE 1/8 W, 5%
2. REFERENCE DRAWING; PC BOARD COMP. ASSY, D-1629029.
3. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH UNIT NUMBER AND ASSEMBLY DESIGNATION.
LIST OF MATERIALS
SCHEMATIC, THRESHOLD DISCRIMINATOR,
X-RAY ASTRONOMY
SPACE CRAFT Inc.
1629028

FIGURE 4.6-2



OUTPUT -12 VDC TELEMETRY
INPUT STAR TUBE #1 TEMP.
INPUT STAR TUBE #2 TEMP.
INPUT P.C. TEMP.
INPUT HOUSING TEMP.
INPUT MOUNTING PLATE TEMP.
CH. 21 GRD
CH. 22 GRD
CH. 23 GRD
CH. 24 GRD
CH. 25 GRD
SYSTEM GRD
SYSTEM GRD
VOLTAGE MONITOR NO. 1
VOLTAGE MONITOR NO. 2
H.V. STAR SENSOR #1 INPUT
H.V. STAR SENSOR #2 INPUT
30 VDC INPUT
NOTES:
1 LAST REFERENCE DESIGNATORS USED ARE R30 VR14 & E41
2 REFERENCE DRAWING FOR PC BOARD ASSEMBLY D-1623103.
3. ALL RESISTORS ARE 1/4 W, 5%. ALL DIODES ARE 1N752A.
4 'E' NUMBERS 25,26,32,33,35,36 OMITTED.
5 PARTIAL REFERENCE DESIGNATIONS ARE SHOWN, FOR COMPLETE DESIGNATION PREFIX WITH UNIT NUMBER AND ASSEMBLY DESIGNATION.
6 R11 & R12 ARE OMITTED.
LIST OF MATERIALS
SCHEMATIC, ANALOG SIGNAL CONDITIONER
SPACE CRAFT Inc.
HUNTSVILLE, ALA
1629101
SCALE NONE
SHEET 1 OF 1

FIGURE 4.7-1

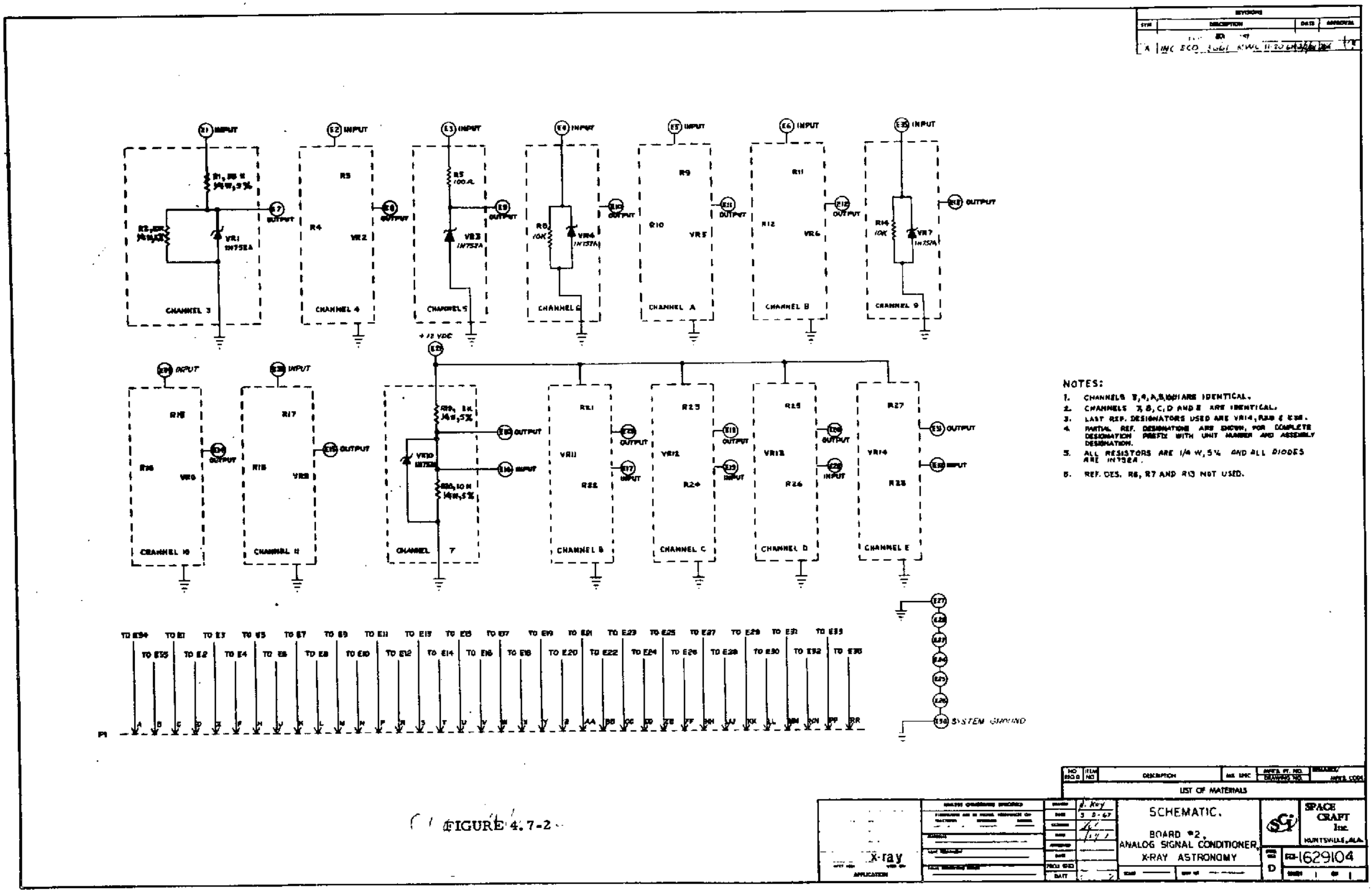

CHANNEL 3
CHANNEL 4
CHANNEL 5
CHANNEL 6
CHANNEL A
CHANNEL 8
CHANNEL 9
CHANNEL 10
CHANNEL 11
CHANNEL 7
CHANNEL B
CHANNEL C
CHANNEL D
CHANNEL E
INPUT
OUTPUT
+12 VDC
VR1 1N752A
VR3 1N752A
SYSTEM GROUND
NOTES:
1. CHANNELS 3,4,A,8,10,11 ARE IDENTICAL.
2. CHANNELS 7, B, C, D AND E ARE IDENTICAL.
3. LAST REF. DESIGNATORS USED ARE VR14, R28 & E38.
4. PARTIAL REF. DESIGNATIONS ARE SHOWN, FOR COMPLETE DESIGNATION PREFIX WITH UNIT NUMBER AND ASSEMBLY DESIGNATION.
5. ALL RESISTORS ARE 1/4 W, 5% AND ALL DIODES ARE 1N752A.
6. REF. DES. R6, R7 AND R13 NOT USED.
LIST OF MATERIALS
DESCRIPTION
X-ray
APPLICATION
SCHEMATIC,
BOARD #2,
ANALOG SIGNAL CONDITIONER,
X-RAY ASTRONOMY
SPACE CRAFT Inc.
HUNTSVILLE, ALA.
D
1629104

FIGURE 4.7-2

4.8 STAR SENSOR AMPLIFIERS

A photograph of the star sensor assembly is shown in figure 4.8-1 and a schematic is shown in figure 4.8-2.

The assembly consists of an Electrometer module and a Buffer Amplifier module.

The Electrometer Module will effectively measure a current as low as 5×10^{-12} amps producing an output of 5 millivolts. The electrometer achieves good stability by the use of differential field-effect devices and exhibits a high input impedance to prevent loading of the photomultiplier tubes.

A high intensity light protection circuit is included in the electrometer and utilizes the property that the voltage output of the electrometer is proportional to the current from the tube.

To prevent solar electric damage to the tube, prevent tube saturation and limit the tube's recovery time from high light levels, the tube's output is held to a constant current of 10^{-8} amps. The equivalent electrometer output (about 6 volts) is returned through a linear amplifier to a control line in the voltage regulation section of the H.V. power supply. When tube current through reduction of the tube's current gain by decreasing the high voltage into the tube.

The Buffer Amplifier module is directly coupled to the electrometer output and has a switchable gain which provides a x 10 gain for low level signals and a x 1 gain for higher levels which effectively extends the dynamic range about three orders of magnitude.

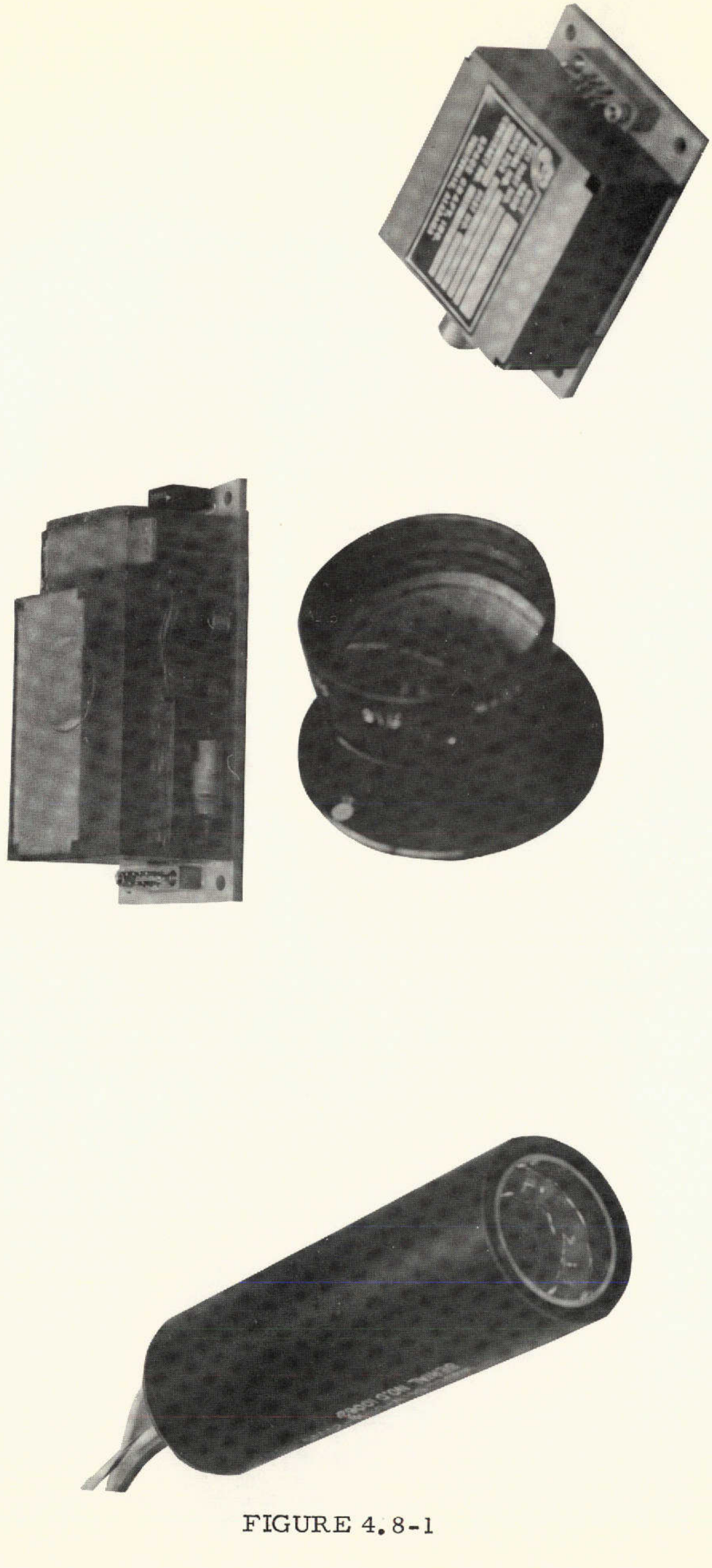


FIGURE 4.8-1

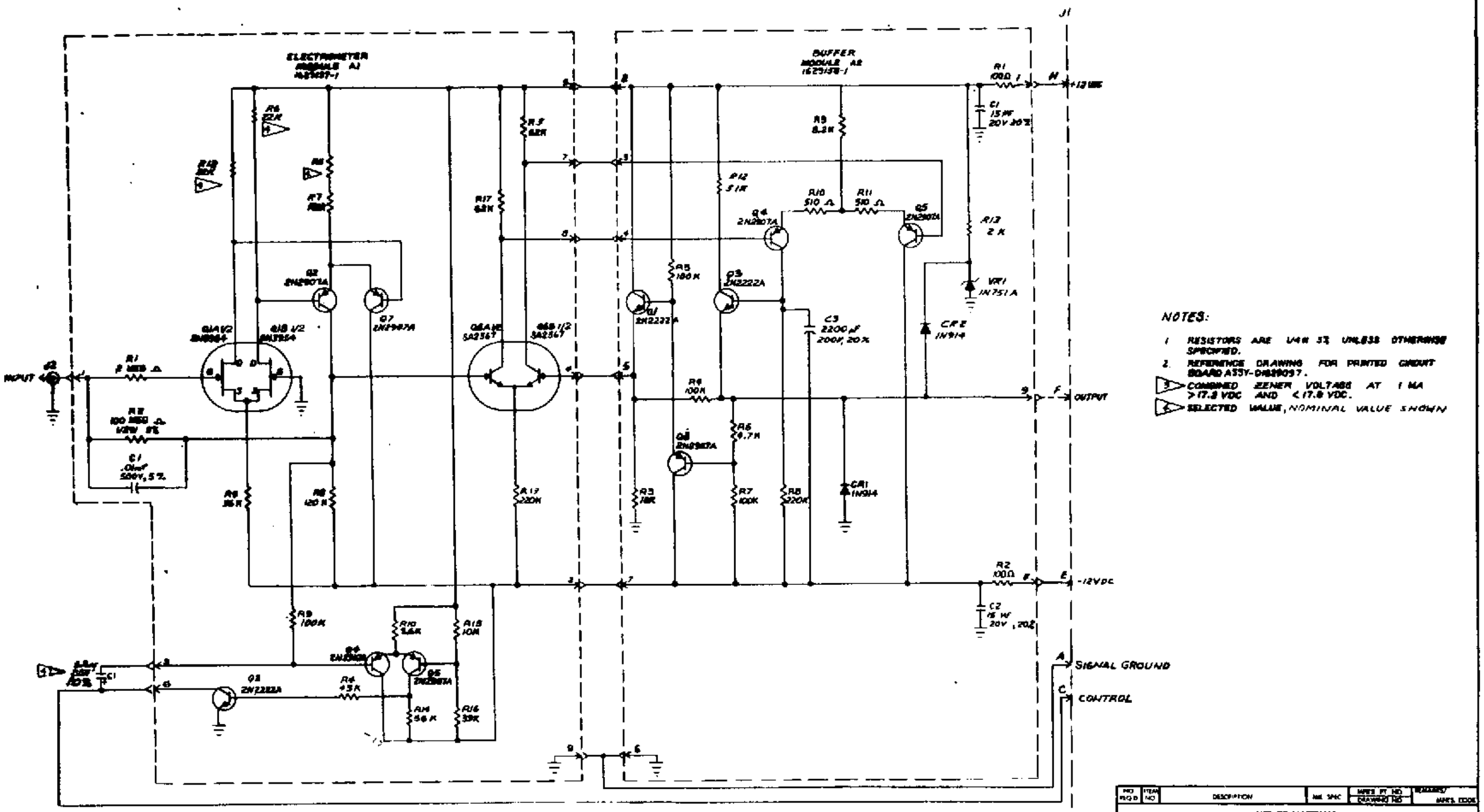


FIGURE 4.8-2

LIST OF MATERIALS

SCHEMATIC, P.C. BOARD, STAR SENSOR AMPLIFIER, X-RAY ASTRONOMY

SPACE CRAFT Inc. HUNTSVILLE, ALA

D 1629095

SHEET 1 OF 1

4.0 LOW VOLTAGE POWER SUPPLY

All voltages required in the S-150 experiment are developed in the Low Voltage Power Supply from the spacecraft +28 volt bus. A photograph, block diagram, and schematics of the supply are shown in figures 4.9-1. thru 4.9-5. The supply provides experiment power isolated from the +28 volt system by chopping and transformer coupling the primary voltage. The transformer has multiple secondary windings which are regulated and filtered to provide the final output to the experiment. In addition to providing the experiment voltages the 12 Vdc, +35 Vdc, +4 Vdc and +5.5 Vdc the supply generates a 5 kHz, p-p square-wave clock for the high voltage power supplies.

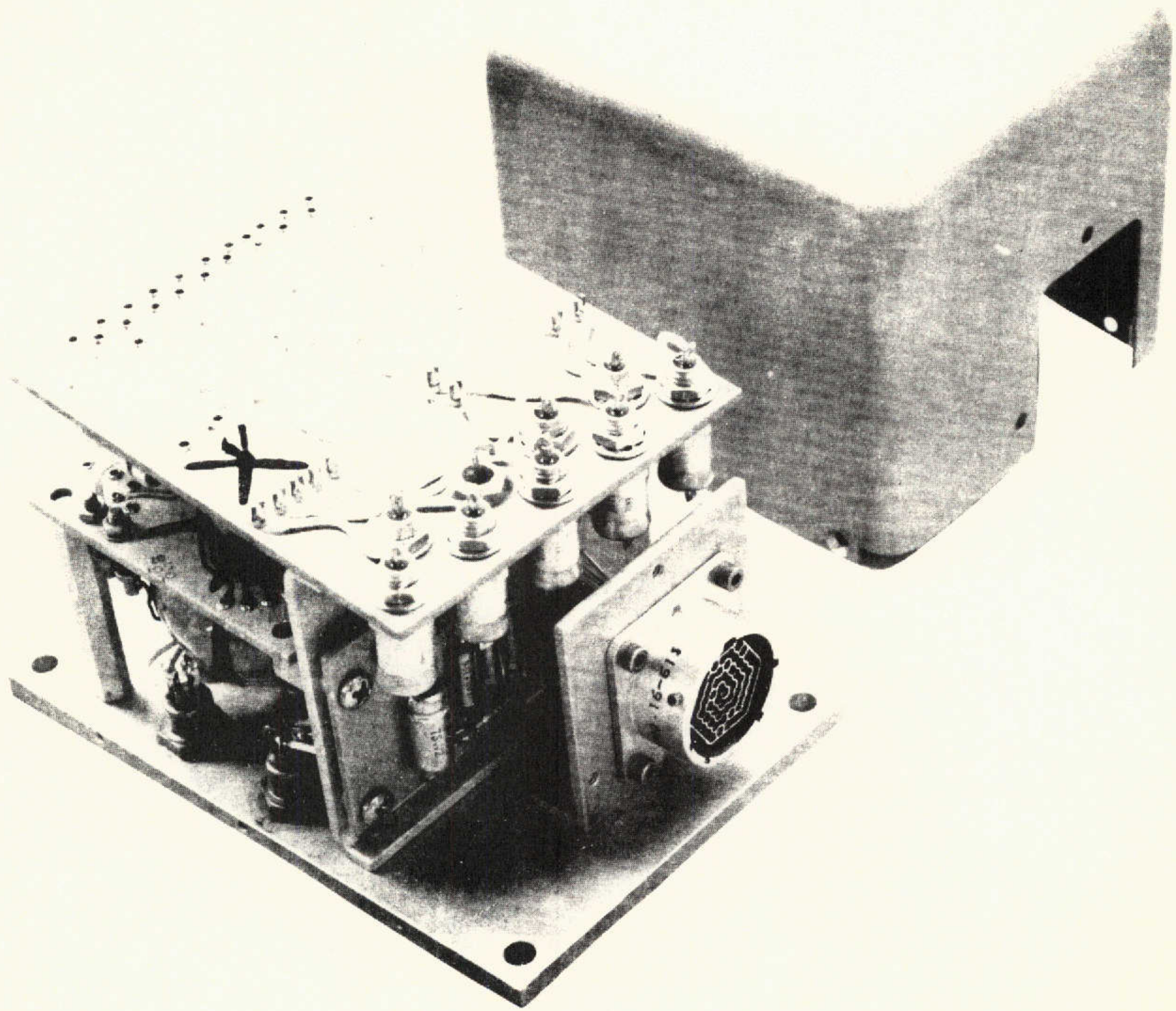
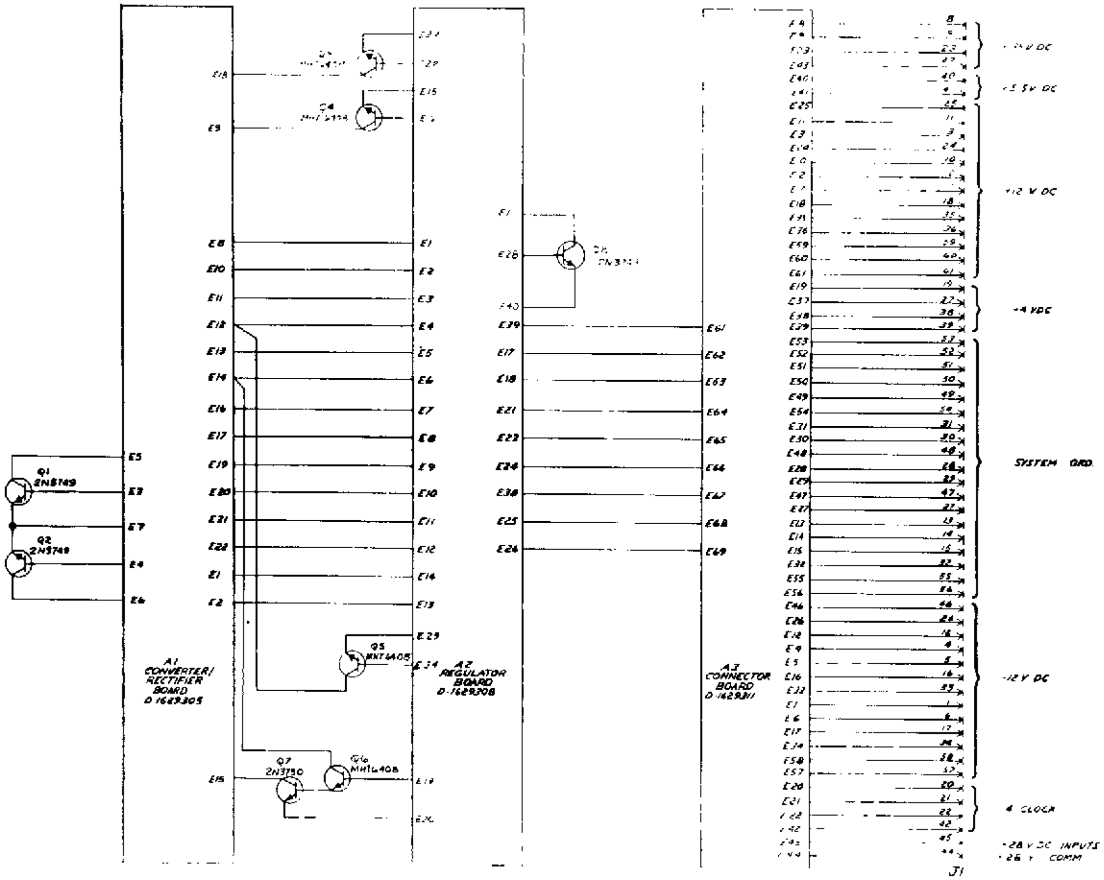


FIGURE 4.9-1

S-027 X-RAY ASTRONOMY EXPERIMENT

LOW VOLTAGE POWER SUPPLY



NOTES:
1. LAST REFERENCE DESIGNATORS USED ARE Q8, A3 & J1
2. PARTIAL REFERENCE DESIGNATION SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH UNIT NO. & ASS'Y DESIGNATION.
3. REFERENCE DRAWING FOR TOP ASSEMBLY D-1629392

FIGURE 4.9-2

LIST OF MATERIALS

BLOCK DIAGRAM

SPACE CRAFT Inc.

D 1629313

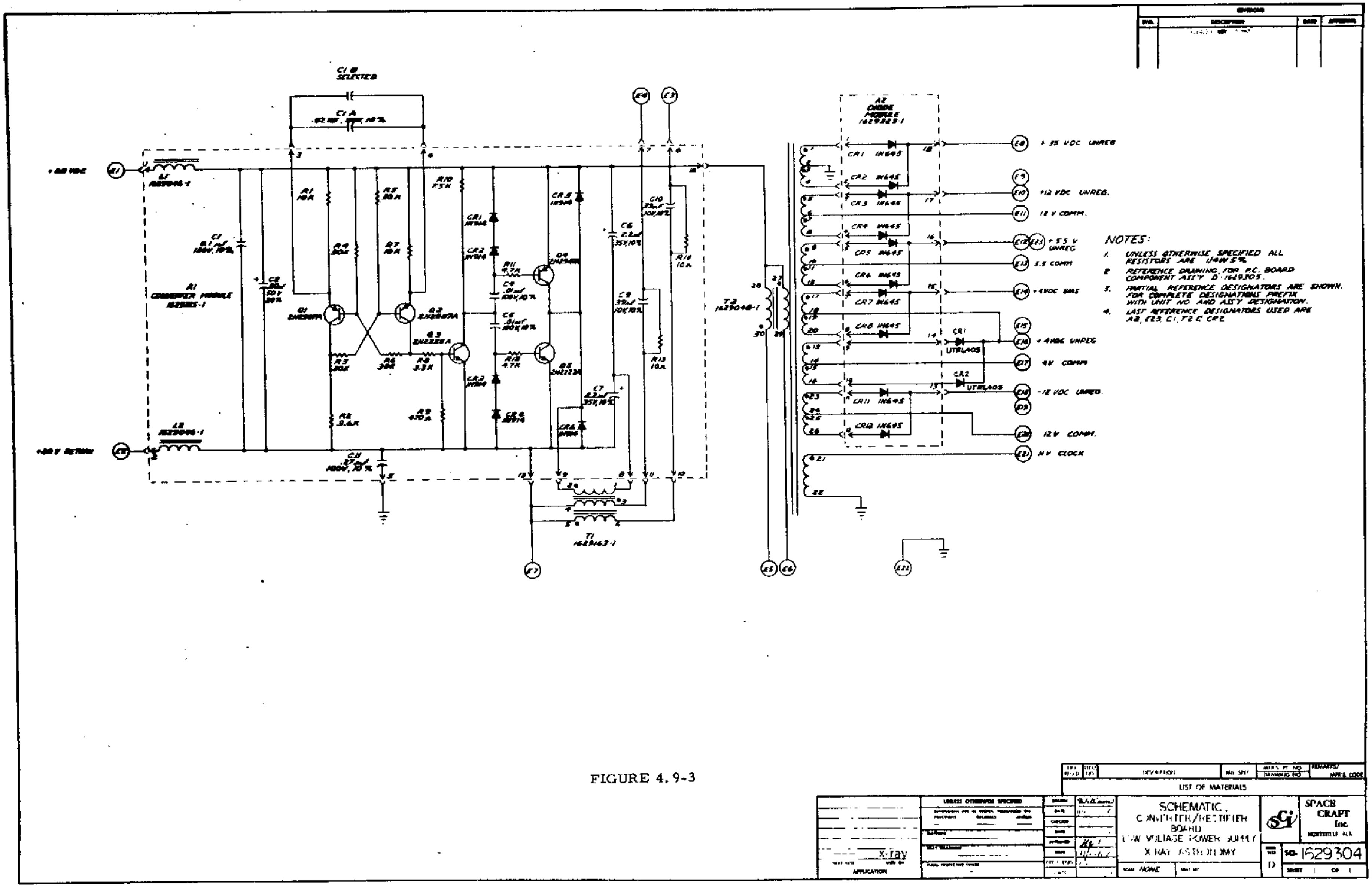

NOTES:
1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE 1/4W 5%
2. REFERENCE DRAWING FOR P.C. BOARD COMPONENT ASS'Y D 1629305.
3. PARTIAL REFERENCE DESIGNATORS ARE SHOWN. FOR COMPLETE DESIGNATIONS PREFIX WITH UNIT NO. AND ASSY DESIGNATION.
4. LAST REFERENCE DESIGNATORS USED ARE A2, E23, C1, T2 & CR2.
SCHEMATIC, CONVERTER/RECTIFIER BOARD
LOW VOLTAGE POWER SUPPLY
X-RAY ASTRONOMY
SPACE CRAFT Inc.
1629304

FIGURE 4.9-3

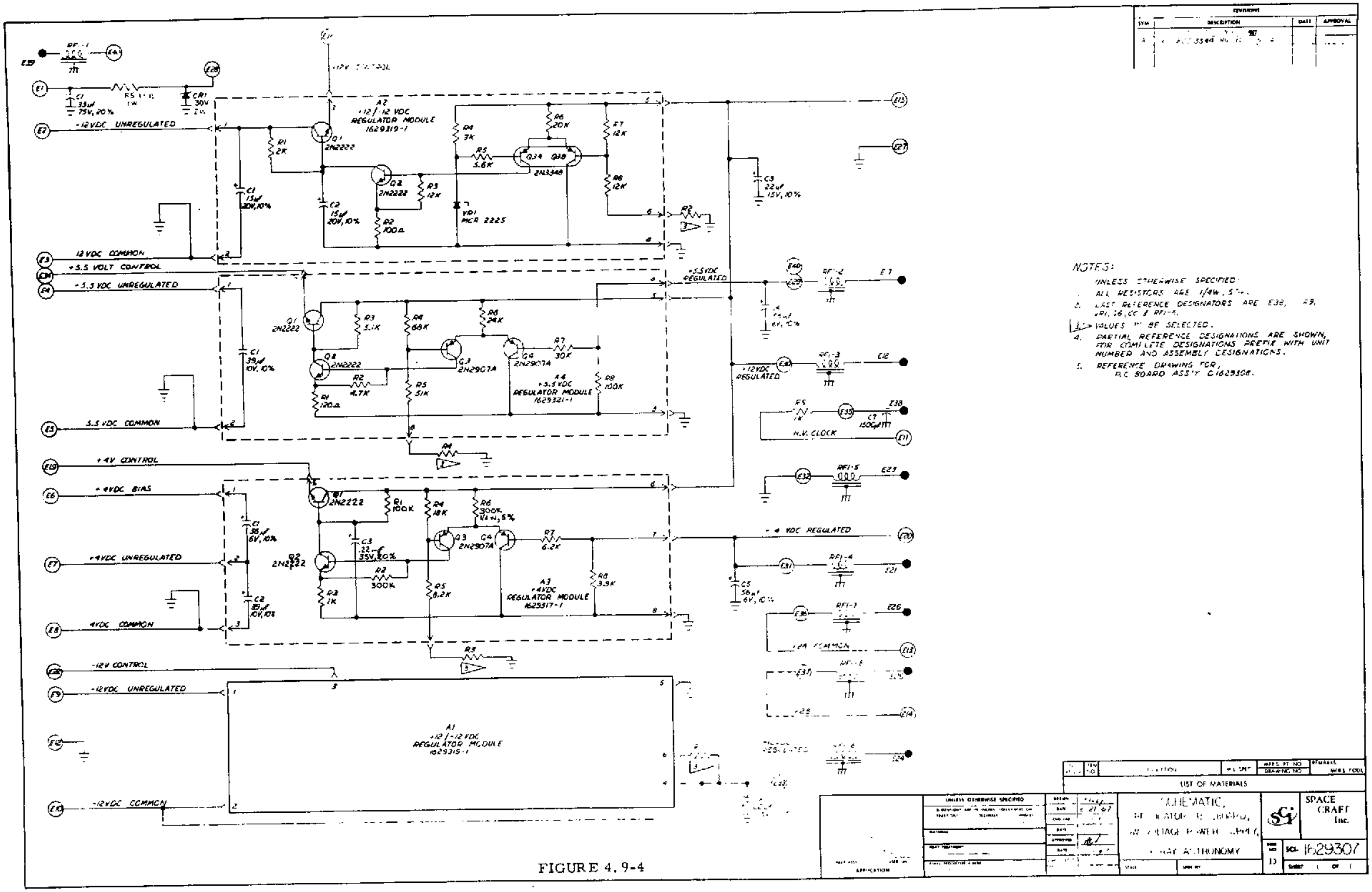
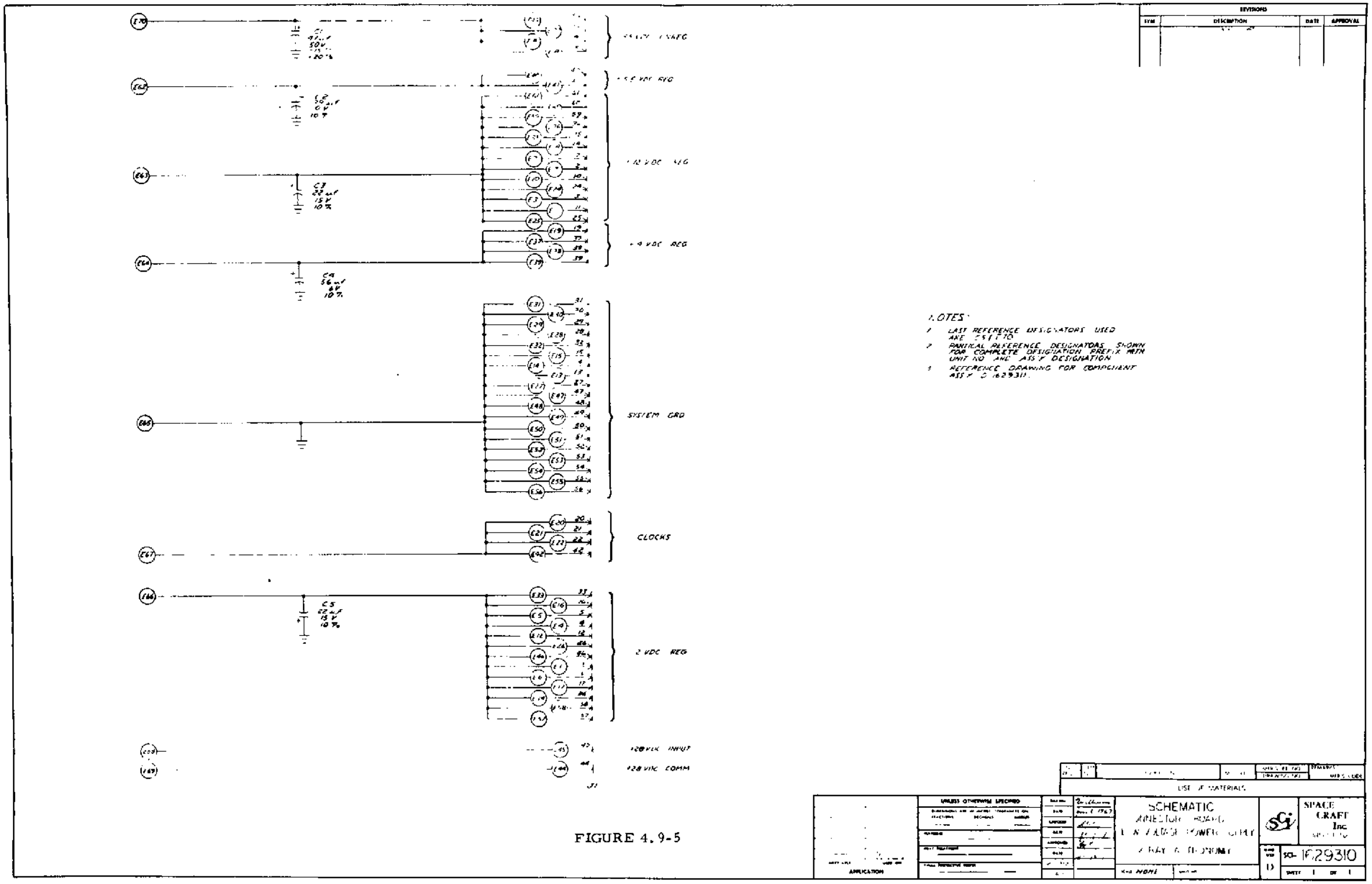

+12VDC UNREGULATED
12VDC COMMON
+5.5 VOLT CONTROL
+5.5 VDC UNREGULATED
5.5 VDC COMMON
+4V CONTROL
+4VDC BIAS
+4VDC UNREGULATED
4VDC COMMON
-12V CONTROL
-12VDC UNREGULATED
-12VDC COMMON
A2
+12/-12 VDC
REGULATOR MODULE
1629319-1
A4
+5.5 VDC
REGULATOR MODULE
1629321-1
A3
+4VDC
REGULATOR MODULE
1629317-1
A1
+12/-12 VDC
REGULATOR MODULE
1629315-1
+5.5VDC REGULATED
+12VDC REGULATED
H.V. CLOCK
+4 VDC REGULATED
NOTES:
UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE 1/4W, 5%.
VALUES TO BE SELECTED.
PARTIAL REFERENCE DESIGNATIONS ARE SHOWN, FOR COMPLETE DESIGNATIONS PREFIX WITH UNIT NUMBER AND ASSEMBLY DESIGNATIONS.
REFERENCE DRAWING FOR, P.C BOARD ASS'Y C1629306.
LIST OF MATERIALS
UNLESS OTHERWISE SPECIFIED
SCHEMATIC,
X-RAY ASTRONOMY
SPACE CRAFT Inc.
1629307
APPLICATION

FIGURE 4.9-4



+12 VDC REG
+4 VDC REG
SYSTEM GRD
CLOCKS
2 VDC REG
28 VDC INPUT
28 VDC COMM
NOTES:
1 LAST REFERENCE DESIGNATORS USED ARE
2 PARTIAL REFERENCE DESIGNATORS SHOWN FOR COMPLETE DESIGNATION PREFIX WITH UNIT NO AND ASS'Y DESIGNATION
3 REFERENCE DRAWING FOR COMPONENT ASS'Y
LIST OF MATERIALS
SCHEMATIC
SPACE CRAFT Inc
SCI
APPLICATION
UNLESS OTHERWISE SPECIFIED
NONE
D
SCI-
1629310
SHEET 1 OF 1

FIGURE 4.9-5

4.10 DIGITAL DATA PROCESSOR

The S-150 uses the same data processor as the S-027 experiment. The digital data processor utilizes high density integrated circuit, welded module packaging concepts. A photograph of the processor is shown in figure 4.10-1 and a block diagram is shown in figure 4.10-2. The majority of the system is involved with the primary detector's level discriminators. Capabilities exist to accept 50 lines of pulse data into the unit providing 10 bit accumulation (1023 counts) for each input. Sequencing of data outputs is derived from timing inputs from the IU. Twelve separate data sequence enables five accumulators of 10 bits each to the output circuitry. The 1 pps timing signal from the IU synchronizes the system by ordering the proper sequence of data groups. At the leading edge of the 12 pps pulse, the data accumulators to be interrogated are inhibited from further counting, and their outputs are presented to the digital data interface. The outputs remain available for sampling by the IU for a period of 700 microseconds at the end of which time the accumulators are reset and the input inhibit is lifted. At the next 12 pps pulse the second group of accumulators are connected to the output.

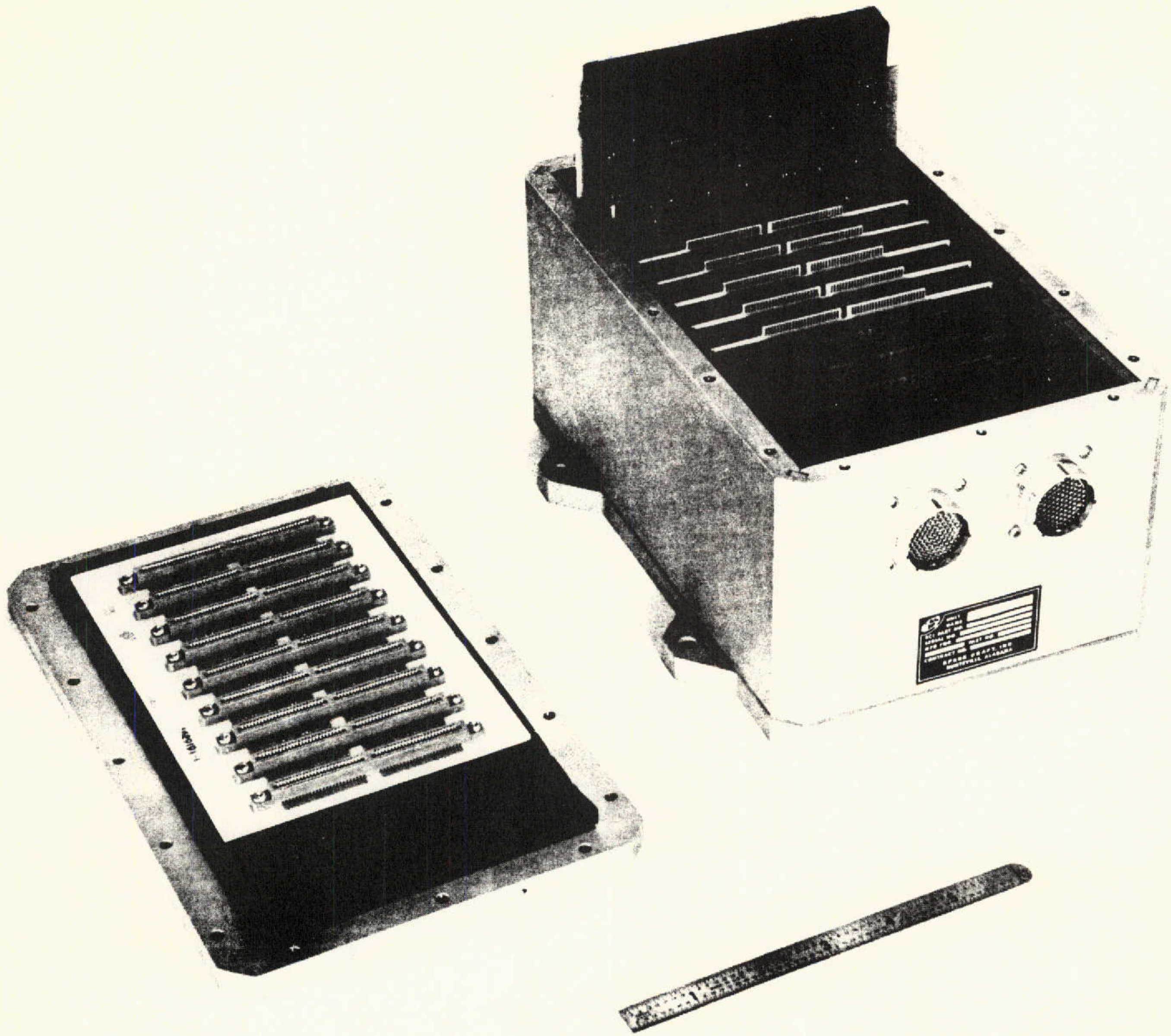


FIGURE 4.10.1
DIGITAL DATA PROCESSOR

X-RAY ASTRONOMY

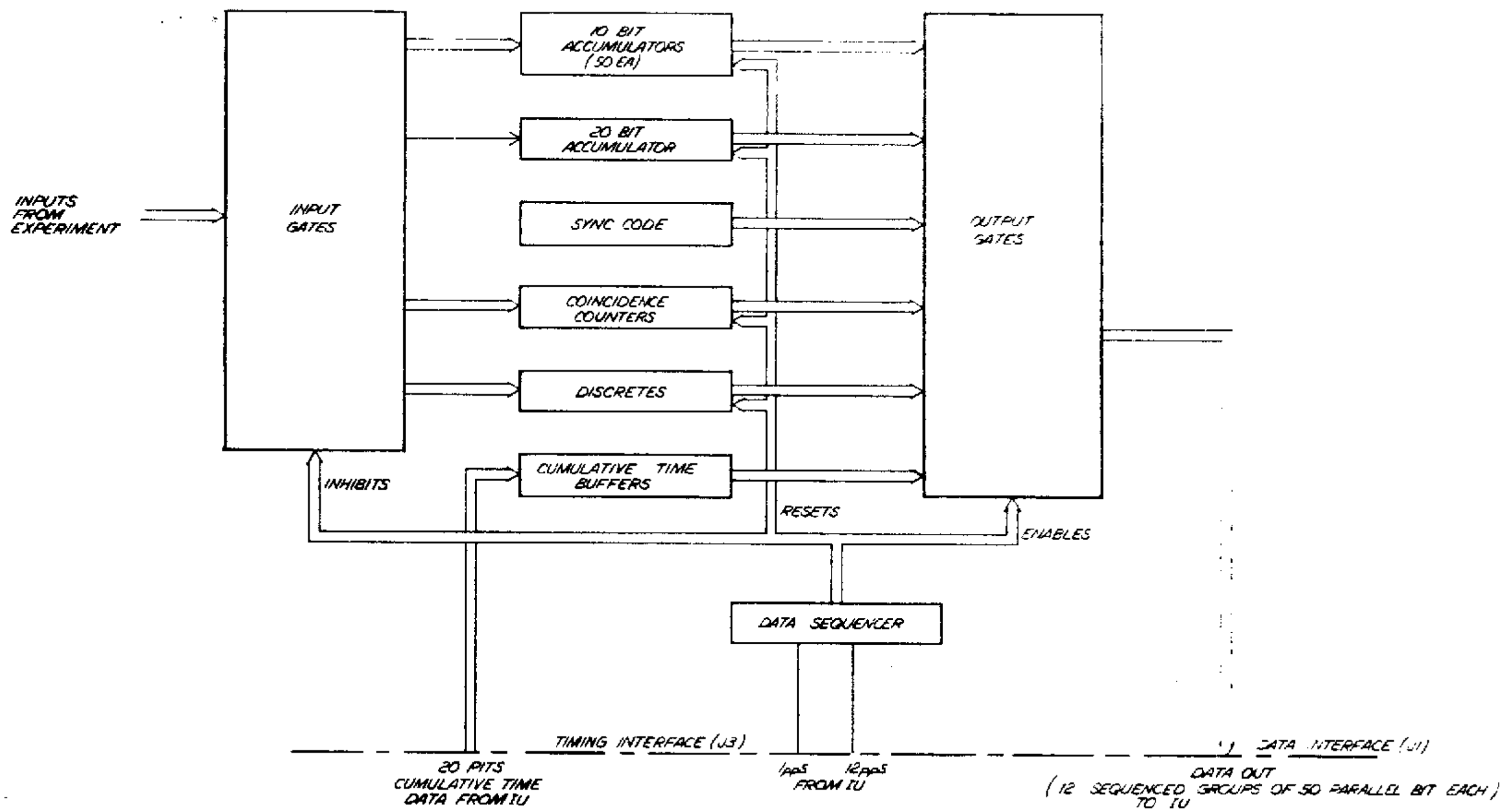


FIGURE 4.10-2

ITEM NO.	QTY REQ'D	NOMENCLATURE OR DESCRIPTION	CODE IDENT. NO.	PART OR IDENT. NO.	SPEC.	MATERIAL OR NOTE

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS DECIMALS ANGLES

MATERIAL

DIMENSIONS AND TOLERANCES APPLY BEFORE FINAL FINISH

FINISH

NEXT ASS'Y | USED ON
APPLICATION

DR. KELLY 5-15-68
DSGN.
CHK.
APPD.
PROJ. ENG.
DESIGN APPROVAL
OTHER APPROVAL

Space Craft Inc.
HUNTSVILLE, ALA

BLOCK DIAGRAM,
DIGITAL DATA PROCESSOR
S027 X RAY ASTRONOMY EXP.,

SIZE C | CODE IDENT. NO. 17981 | DWG NO. 3157

SCALE | UNIT WT. | SHEET OF

SCI FORM NO. 810-041 NOV. 1966

5.0 ENVIRONMENTAL TEST

The S-150 Qualification Unit was subjected to environmental tests per SCI-1629-005 Qualification Test Plan.

In addition to test performed on the completed experiment, each subassembly was subjected to appropriate environmental tests and qualified prior to installation in the experiment.

TEST SEQUENCE AND QUALIFICATION SCHEDULE

The environmental tests were performed in the following order:

(1) Electromagnetic compatability

(2) Accoustic noise

(3) Acceleration

(4) Thermal vacuum with a storage window

(5) Vibration

(5.1) Sine each axis

(5.2) Random each axis

(6) Thermal vacuum (flight window)

(7) Pyrotechnic shock

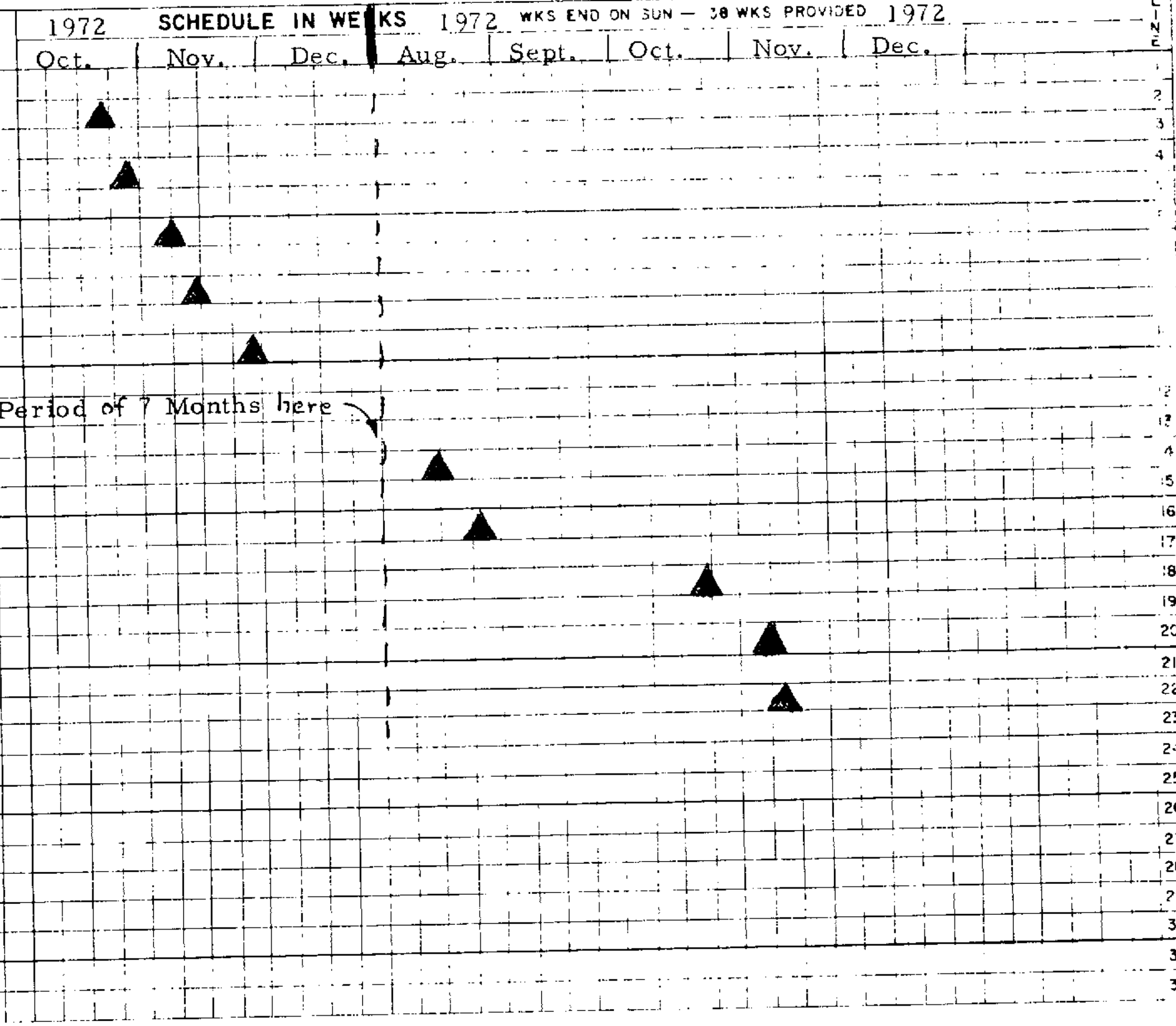
The vibration, thermal vacuum and pyrotechnic shock tests with a flight window (tests 5, 6 and 7) were performed with minimum time delay between tests to more realistically subject the thin film window to launch conditions and at the same time minimize the possibility of window degradation from non-launch environmental conditions.

FUNCTIONAL MASTER PLAN

PROJ X-Ray PAGE 1 OF 1
ISSUED 11-30-72
REVISED -
PREPARED G. Frohwein
APPROVED G. Frohwein

TITLE S-150 Qualification Schedule
CUSTOMER University of Wisconsin
CONTR NR

LINE	TASKS / MILESTONES
1	
2	R.F.I. Testing (SCI)
3	
4	Thermal Vacuum (Wyle)
5	
6	Acoustic Test (Wyle)
7	
8	Acceleration (Wyle)
9	
10	Vibration Test (Wyle)
11	
12	Bracket Qual & Rework
13	
14	Thermal Vac (SW) (SCI)*
15	
16	Vibration (SW) (SCI)*
17	
18	Vibration (FW) (SCI)*
19	
20	Thermal Vac (FW) (SCI)*
21	
22	Pyrotechnic Shock (SCI)
23–32	



*SW - Storage Window
*FW - Flight Window

ENVIRONMENTAL TEST AND PERFORMANCE SUMMARY

Environmental testing was started 20 October 1971 with RFI testing. In broadband radiated the S-150 sensor unit was out of specification from .15 MHz to 1.5 MHz, an expected condition that almost exactly duplicates the old S-027 RFI data.

Thermal Vacuum was started at Wyle Labs on 27 October 1971. Problems were encountered of storage window leakage. This test was terminated for investigation of window problems.

Testing was begun on 9 November 1971 for Acoustic noise and was successful.

Acceleration testing was begun on 15 November 1971 and was successful.

Vibration at Wyle Labs was commenced on 29 November 1971 and successful in both radial and longitudinal. The lateral axis was terminated because of an uncontrolled "G" buildup. Investigation was started on why this buildup was occurring.

The second Thermal Vacuum test was started on 16 August 1972 at the SCI test facility and was completed successfully using a new storage window support mask on 25 August 1972.

The second Vibration test was started at the SCI test facility on 25 August 1972 using the storage window. The gas system reference tube was broken and the exhaust valve was locked open after the full duration test sequence was complete. These items were returned to the customer for repair and analysis.

The third vibration test was started on 10/23/72 using the flight window. A wire was found loose to the calibrate solenoid, the exhaust valve was stuck open but later operated okay (contamination was the probable cause), and the absolute pressure transducer turned into a differential type by losing its reference vacuum. The open wire was repaired and the transducer was sent to the manufacturer for evaluation. The third Thermal Vacuum test was started on 11/7/72 using the same flight window used in the Vibration testing. The electrical portion of the T. V. test was not performed as the T. V. test intent was to qualify the flight window equivalent for flight. Some increased window leakage was noticed but within the limits imposed for successful experiment operation.

Pyrotechnic Shock was performed on 11/8/72 and was successful.

6. PROCEDURES AND RESULTS

Thermal Vacuum Test

The S-150 X-Ray Experiment was installed in a thermal vacuum chamber as shown in Photograph 1, and the Vacuum Test, as specified in SCI Work Statement, Paragraph 4.0, was commenced.

During the performance of the Thermal Vacuum Test, the SCI Representative indicated that components of the S-150 X-Ray Experiment had failed to function properly. These malfunctions occurred in one of the solenoid relays and a membrane seal. Because of the malfunctions, the SCI Representative stopped the test and rescheduled it at a later date. However, other conditions experienced during the Vibration Test led to the elimination of the thermal vacuum requirement (reference Wyle Notice of Deviation 42184-1).

Acoustic Test

The S-150 X-Ray Experiment was placed in the reverberant chamber of the 1500 cubic foot acoustic facility and was subjected to a low level test spectrum of 146.5 dB for a period of 2 minutes and a high level test spectrum of 153.5 dB for a period of 1 minute. Acoustic spectrums used for the above tests were adjusted prior to placing the specimen in the test area. The calibration spectrums were approved by DCAS QAS and the SCI Representative and are included on Pages 5 and 6 of this report. Detail test data are included on Pages 22 and 23.

Photograph 2 presents the Acoustic Test setup.

At the conclusion of the Acoustic Test, the test specimen was visually inspected. No damage was noted as a result of the test.

Acceleration Test

The S-150 X-Ray Experiment was attached to the arm of a rotary centrifuge and was subjected to 10 g acceleration in both directions of the three orthogonal axes. Test duration for each test was 3 minutes. Detail test data sheets are presented on Pages 24 and 25, and Photograph 3 presents a typical test setup on the centrifuge.

There was no damage noted to the specimen at the conclusion of the Acceleration Test.

RADIO FREQUENCY INTERFERENCE

TEST REPORT

ON

X-RAY ASTRONOMY EXPERIMENT

PREPARED BY

GKBarrell

GAREY K. BARRELL

RFI ENGINEER

SCI SYSTEMS, INC.

TEST RESULTS

CONDUCTED INTERFERENCE

Broadband

Broadband conducted interference on the input power lines of the test item was found to be marginal in compliance with the allowable limits of MIL-I-6181D at .850, 1.0, and 3.5 mHz.

Narrowband

No narrowband signals were detected during this test program.

Data Sheets and Graphs

The data obtained during conducted interference tests is tabulated on Data Sheets 1 and 2. This data is presented graphically in Figure 3.

RADIATED INTERFERENCE

Broadband

Broadband radiated interference emanating from the test item was found to exceed the allowable limits of the specification by as much as 13 db at .150 and .450 mHz.

Narrowband

No narrowband signals were detected during this test program.

Data Sheets and Graphs

The data obtained during the radiated interference tests is tabulated on Data Sheet 3. This data is presented graphically in Figure 4.

SUSCEPTIBILITY

Conducted Radio Frequency

RF conducted susceptibility characterisitcs of the test item were found to be within the allowable limits of MIL-I-6181D. No indication of malfunction or degradation of performance in excess of system specification was detected.

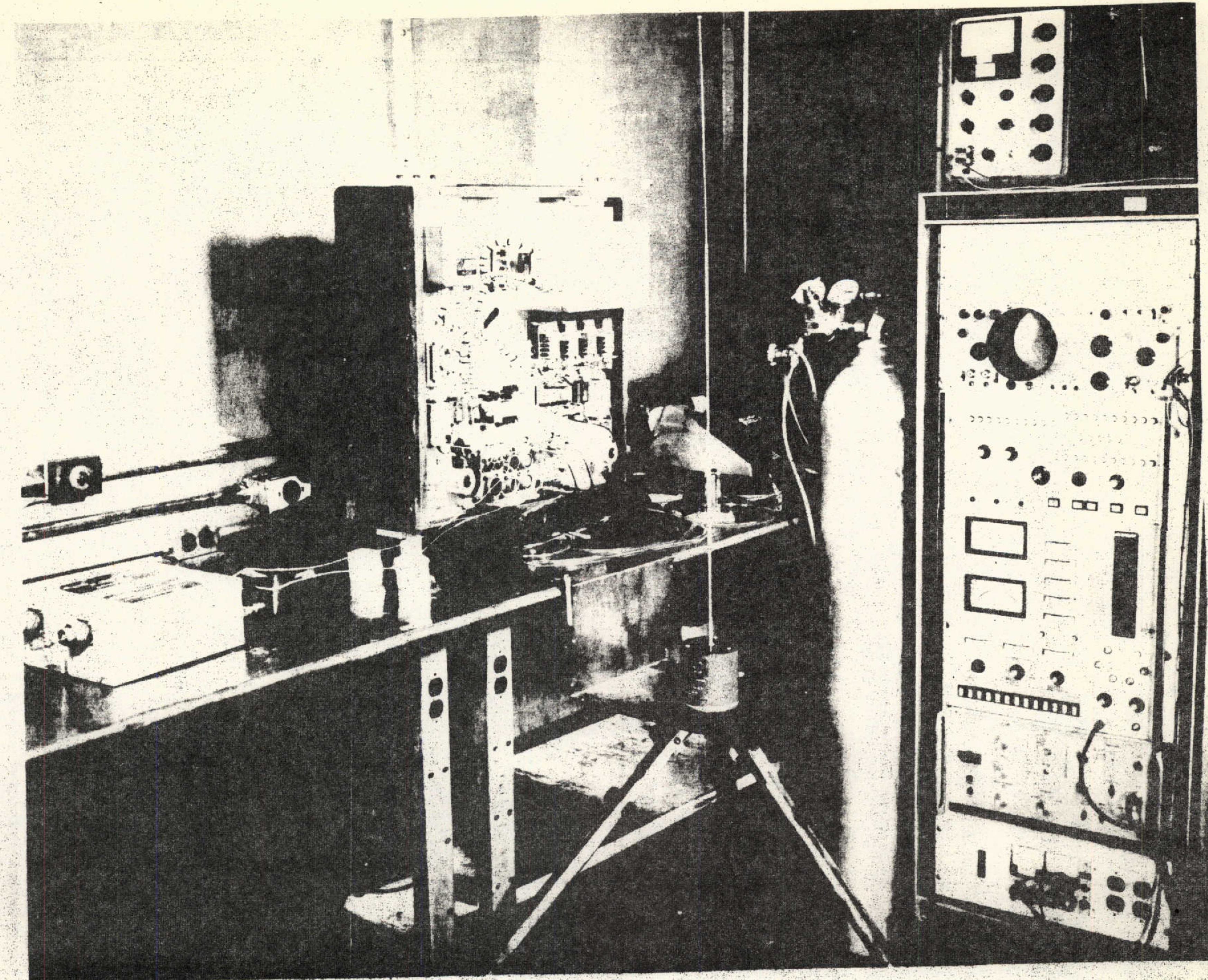
Conducted Audio Frequency

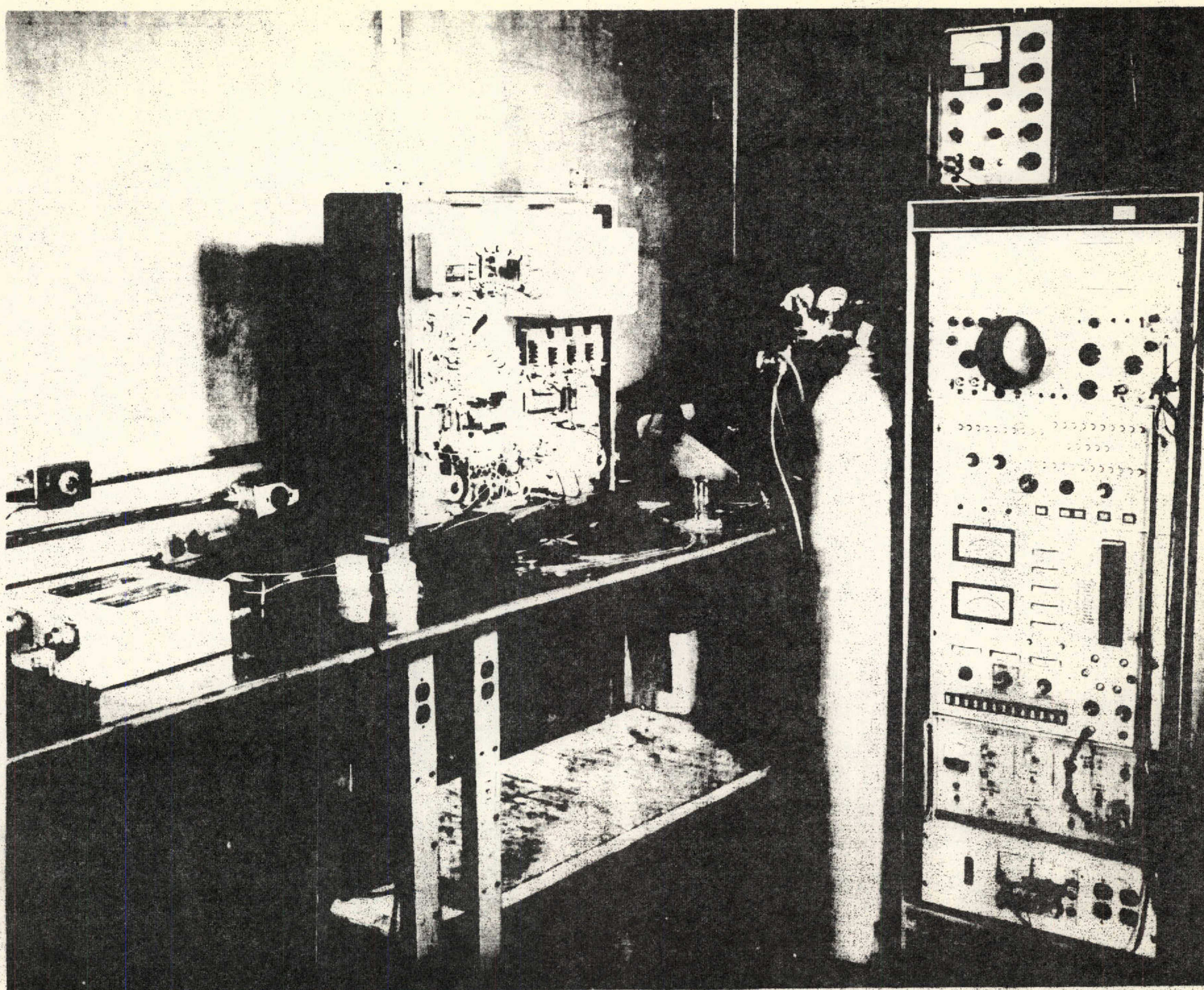
Audio conducted susceptibility characteristics of the test item were found to be within the allowable limits of MIL-I-6181D. No indication of malfunction or degradation of performance in excess of system specification was detected.

Radiated Radio Frequency

Radiated radio frequency characteristics of the test item were found to be within the allowable limits of MIL-I-6181D. No indication of malfunction or degradation of performance in excess of System Specification was detected.

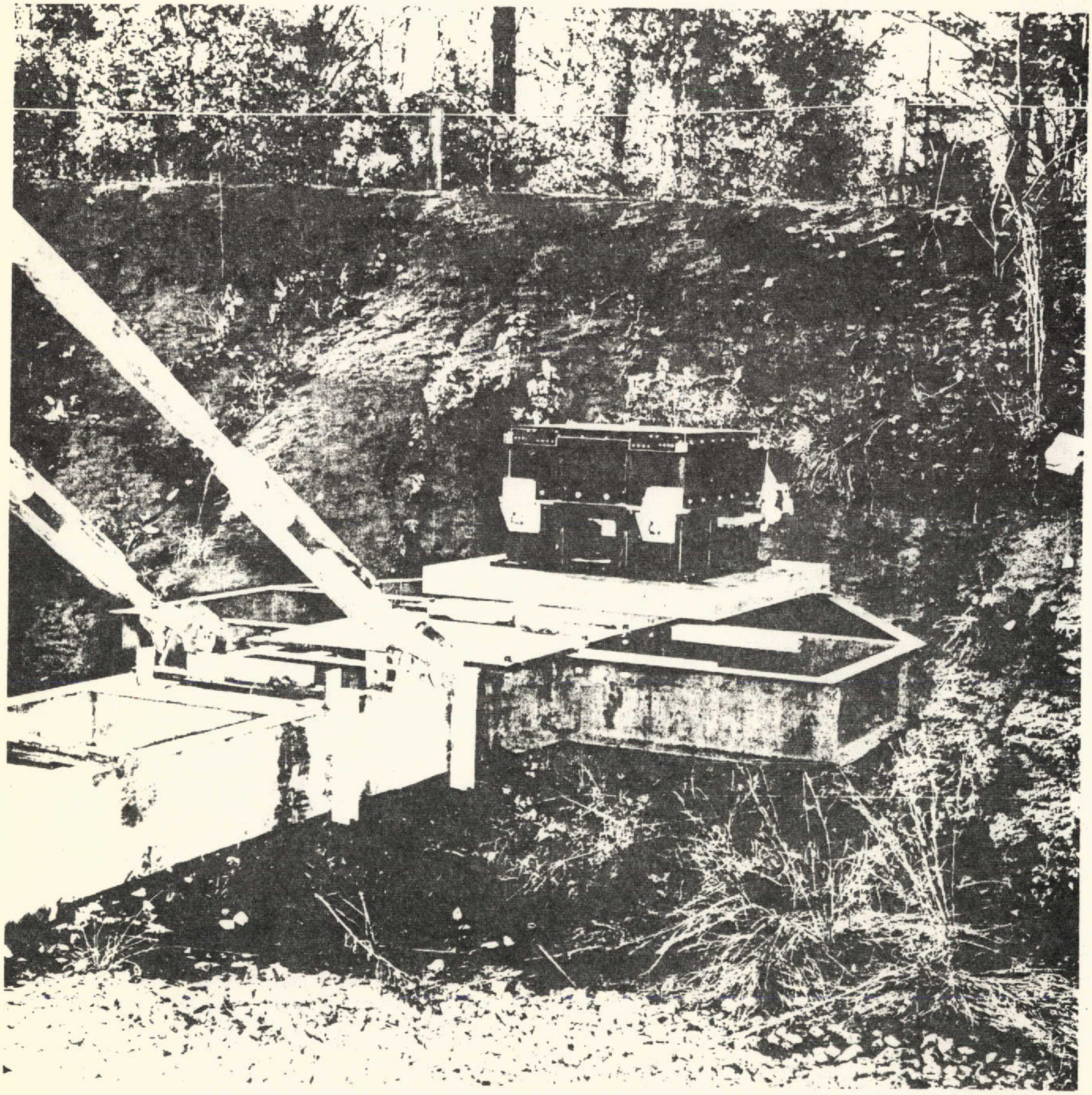
The undersigned certifies that the test information contained in this report is the result of complete and carefully conducted tests and is to the best of his knowledge true and correct in all respects.





ACCELERATION

The S-150 Sensor was given a pre-acceleration checkout in accordance with the Qualification test plan and Procedure. The sensor was subjected to the Acceleration specification 50M71810, para. 5.2.5 in an unpowered condition and pressurized as specified in Section 3.0 of ATP-005. The test was run at Wyle Labs on their acceleration arm or rotary centrifuge and was subjected to 10g acceleration in both directions of the orthogonal axes for three minutes each. Test data is included in this section, with a photograph of the test and specimen setup also in this section. Subsequent to the test, the QTP functional in section 2.0 of the test plan -005 was again given and verified by QC that no electrical nor mechanical deterioration including gas leakage thru the thin window. (Reference Section 8.1.6).



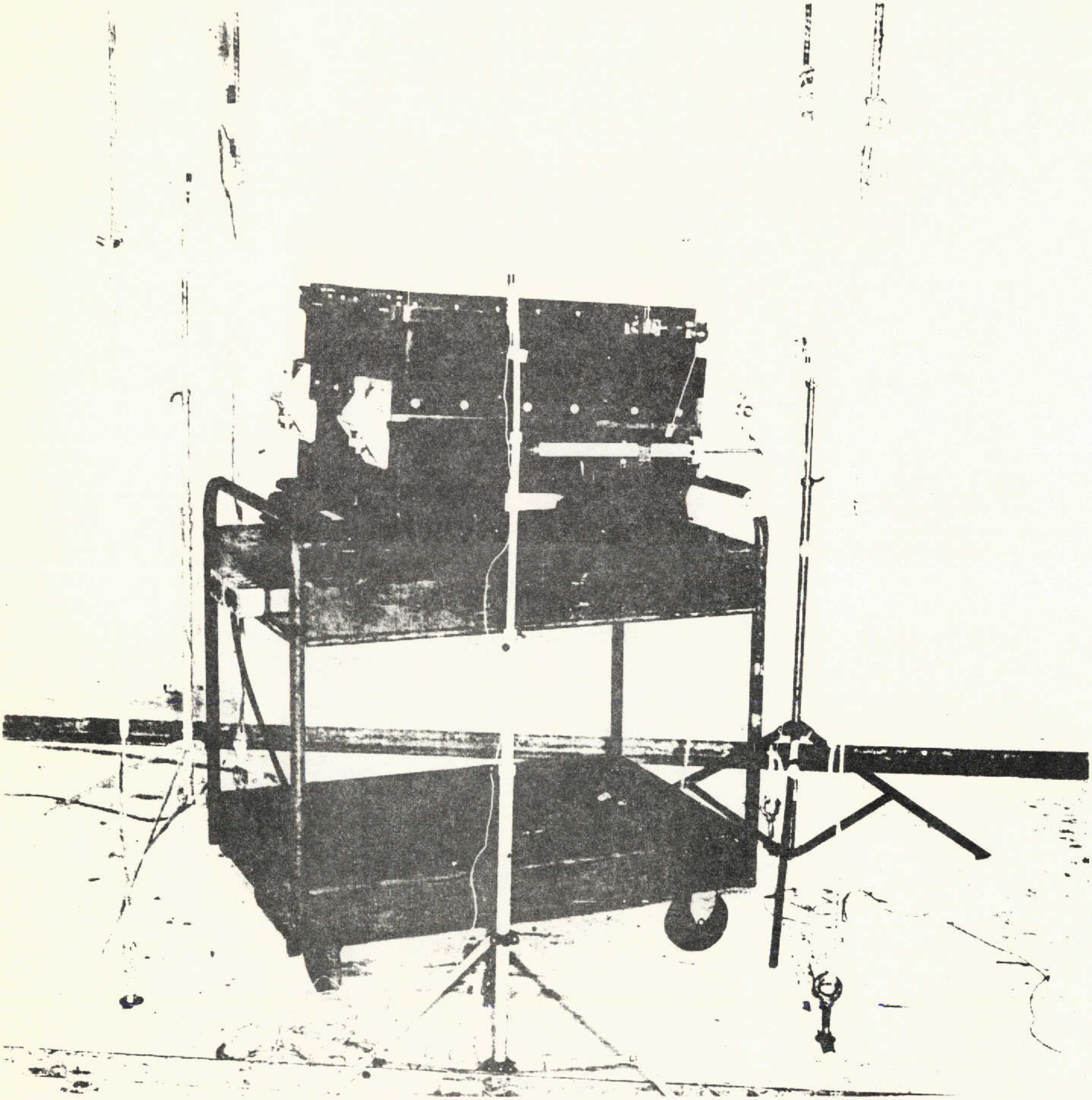
PHOTOGRAPH 3

ACCELERATION TEST SETUP

ACOUSTIC NOISE

The S-150 Sensor was given a preacoustic checkout in accordance with the Qualification Test Plan and Procedure 1629-005 and 1629-QTP-001 Respectively. The sensor was subjected to the Acoustic test of 50M71810 paragraph 5.2.4 in an unpowered condition and pressurized as specified in section 4.0 of QTP -005. The test was run at Wyle Labs in their acoustic lab and was subjected to a low level test spectrum of 146.5 db for a period of two minutes. In addition, a high level test specturm of 153.5 db was run for a period of one minute. All adjustments for acoustical tracking to the specification errors was done prior to the sensor exposure. Reference the actual recorded data runs in this section, with a photograph of the specimen setup.

Subsequent to the test the QTP test was again run no deterioration was noted either electrically or gas leakage (Reference Section 8.1.5).



PHOTOGRAPH 2

ACOUSTIC TEST SETUP

FIRST VIBRATION TESTING

On November 29, 1971 the vibration testing was begun on the S-150 assembly at the Wyle Lab facility in Huntsville. The S-150 sensor was subjected to the following vibration spectrum.

Test	Axis	Levels
Resonant Search (8.5 minute sweep)	Vertical	5 - 31 Hz @ 0.02 in. DA 31 - 900 Hz @ 1.0 g 900 - 2000 Hz @ 0.5 g
Sine Vibration (17 minute sweep)	Vertical	5 - 38 Hz @ 0.08 in. DA 38 - 900 Hz @ 5.8 g 900 - 2000 Hz @ 2.8 g
Random Vibration (5 minute duration)	Vertical	20 - 67 Hz @ +4 dB/octave 67 - 400 Hz @ 0.18 g^2/Hz 400 - 940 Hz @ -6 dB/octave 940 - 2000 Hz @ 0.032 g^2/Hz

Test	Axis	Levels
Resonant Search (8.5 minute sweep)	Longitudinal	5 - 31 Hz @ 0.02 in. DA 31 - 900 Hz @ 1.0 g 900 - 2000 Hz @ 0.5 g
Sine Vibration (17 minute sweep)	Longitudinal	5 - 38 Hz @ 0.08 in. DA 38 - 900 Hz @ 5.8 g 900 - 2000 Hz @ 2.8 g
Random Vibration	Longitudinal	20 - 67 Hz @ +4 dB/octave 67 - 400 Hz @ 0.18 g^2/Hz 400 - 940 Hz @ -6 dB/octave 940 - 2000 Hz @ 0.032 g^2/Hz

In order to maintain the total g rms within the ± 10 percent tolerance, the random vibration PSD level was approximately 2 dB down from full level (reference Wyle Notice of Deviation 42184-3).

Test	Axis	Levels
Resonant Search (8.5 minute sweep)	Lateral	5 - 31 Hz @ 0.02 in. DA 31 - 900 Hz @ 1.0 g 900 - 2000 Hz @ 0.5 g
Sine Vibration (2.2 minute sweep)	Lateral	5 - 38 Hz @ 0.08 in. DA 38 - 67 Hz @ 5.8 g

The sine vibration was stopped at 67 Hz due to extreme resonance experienced on test specimen (reference Wyle Notice of Deviation 42184-4).

The high resonance experienced across the hinge between the deployment bracket and the sensor was investigated and ultimately confirmed during the MSFC deployment bracket qualification testing. (Reference NASA Letter S&E-ASTN-ADV (72-49) and letter to Mr. Steve Rose from Dr. Alan Bunner dated January 26, 1972, subject, "Minutes from MSFC Meeting Concerning S-150 Testing".

* These documents are included in the Deviations and Waviers Section 10.0

Standard QTP tests were given before and after the vibration runs. The data sheets for these tests are shown in Section 8.1.7.

CERTIFICATION TEST REPORT

WYLE LABORATORIES

SCI Electronics, Inc.
P. O. Box 4208
Huntsville, Alabama

REPORT NO. 42184-1
WYLE JOB NO. 42184
CUSTOMER P. O. NO. 73109
CONTRACT NAS8-21015
MANUFACTURER SCI Electronics, Inc.
29 PAGE REPORT
DATE March 21, 1972

1. SPECIMEN X-Ray Experiment
2. PART NO. S-150 3. SERIAL NO. N/A
4. EQUIPMENT USED

APPARATUS	MFG.	MODEL NO.	ACCURACY	DATE OF LAST CALIB.
See Attached	Data Sheets			

5. REQUIREMENTS

One S-150 X-Ray Experiment shall be subjected to the Thermal Vacuum Test, Acoustic Test, Acceleration Test, and Vibration Test as specified in SCI Electronics, Inc. Work Statement and Purchase Order Number 73109.

All testing shall be witnessed by DCAS QAS and Wyle Quality Engineering.

STATE OF ALABAMA
COUNTY OF MADISON }ss

William W. Holbrook being duly sworn, deposes and says: That the information contained in this report is the result of complete and carefully conducted tests and is to the best of his knowledge true and correct in all respects.

SEAL

SUBSCRIBED and sworn to before me this 21st day of March, 19 72

Notary Public in and for the County of Madison, State of Alabama

My Commission expires 12-15, 19 76

TEST BY Commercial Projects
PROJ. ENGINEER C. O. Bates
CUSTOMER WITNESS N/A
QAS DCAS William W. Mason
QUALITY CONTROL B. R. Shadrick

WYLE LABORATORIES TESTING DIVISION HUNTSVILLE FACILITY

NOTICE OF DEVIATION

WYLE JOB NO. 42184
NOD NO. 42184-4
PO NO. 73109
DATE 11-30-71

TO: SCI

ATTN: Mr. Jim Cobb

PART NAME X-Ray Experiment

PART NO. S-150 SERIAL NO. N/A

TEST Vibration

SPECIFICATION SCI Work Statement PARAGRAPH NO 1.0

NOTIFICATION MADE TO: Mr. D. Norris

DATE 11-30-71 BY Witness VIA N/A

SPECIFICATION REQUIREMENTS:

The X-Ray Experiment shall be subjected to a resonant search in the lateral axis in order to determine major resonances on the Experiment and its mounting bracket. Test levels shall be as follows:

5 - 38 Hz @ 0.02 in. DA
38 - 900 Hz @ 1.0 g peak
900 - 2000 Hz @ 0.5 g peak

DESCRIPTION OF DEVIATION:

The resonant search in the lateral-axis was stopped at the direction of the SCI Representative due to a severe resonant condition at 67 Hz.

The accelerometer control points were changed and the resonant search as specified was performed in the lateral axis. However, due to the number of resonances noted and the amplitude of the resonances, the lateral axis vibration at this point was terminated by the SCI Representative.

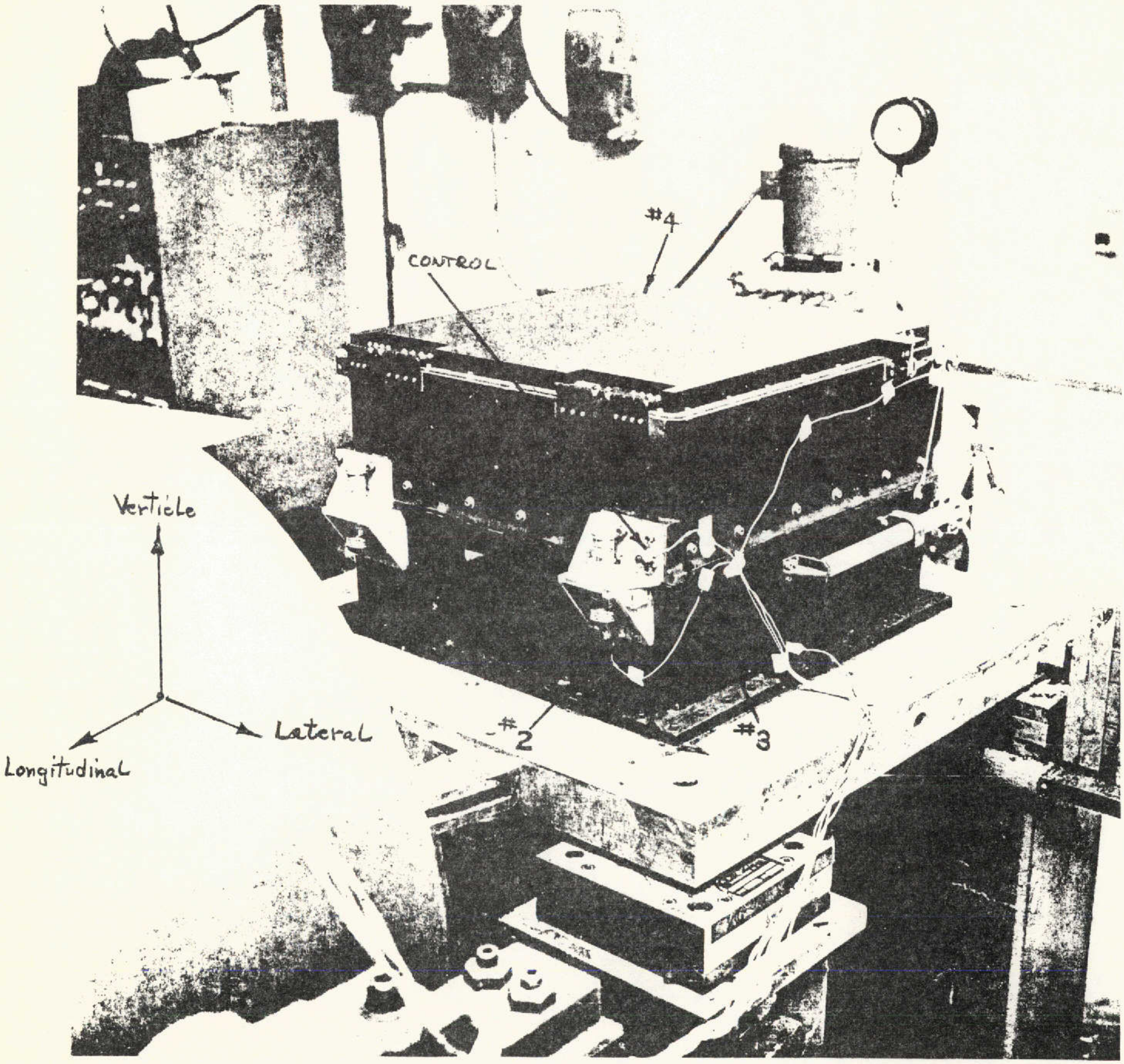
SPECIMEN DISPOSITION Specimen returned to SCI and at the direction of SCI, no future tests were performed.

COMMENTS - RECOMMENDATIONS:

DISTRIBUTION:
Original: Department
( ) Copies: Customer
1 Copy: Quality Control
1 Copy: Field Engineering
1 Copy: Project Office
1 Copy: Contracts

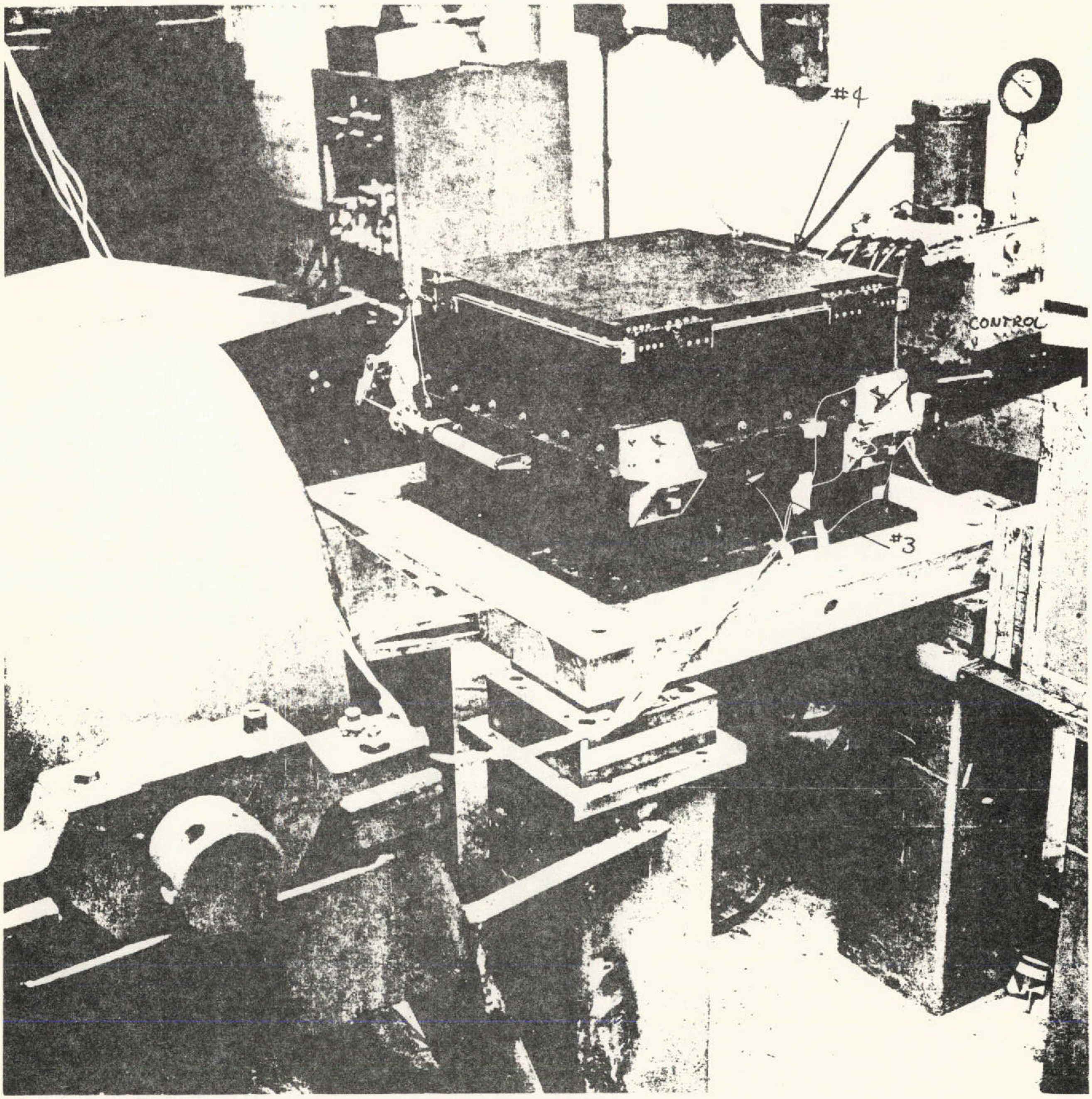
TEST WITNESS: ______ TEST ENGINEER [signature]

REPRESENTING ______ BRANCH HEAD [signature]



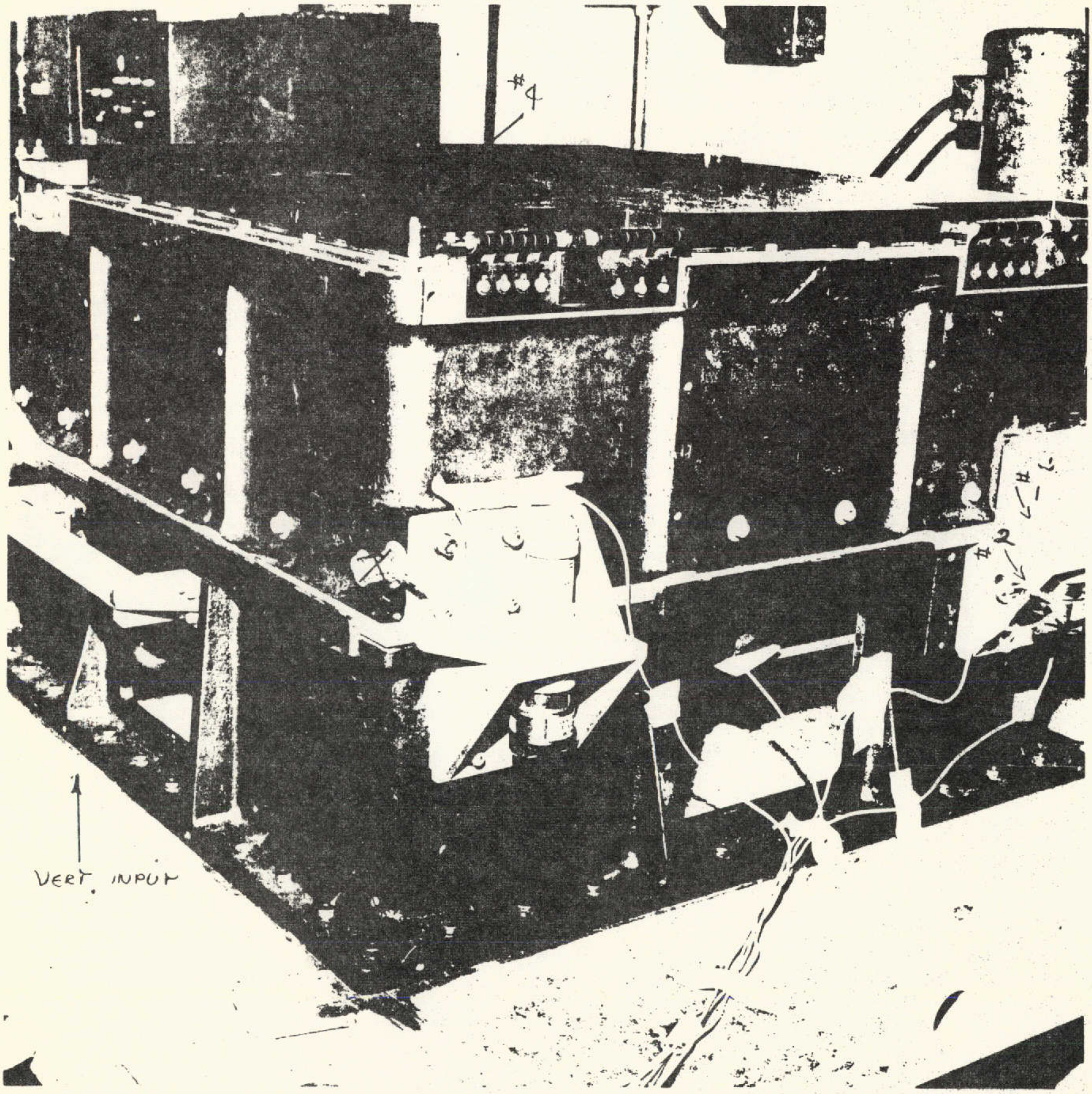
PHOTOGRAPH 4

LONGITUDINAL AXIS SETUP



PHOTOGRAPH 5

LATERAL AXIS SETUP



PHOTOGRAPH 6

VIBRATION TEST SETUP

42184-5

VIBRATION #2 Date: August 25, 1972

The vibration test was performed per paragraph 5.0 of the Acceptance Test Plan 1629-005 Revision B using a storage window.

The sensor successfully completed both sine and random vibration in the longitudinal and lateral axis and sine vibration in the radial axis. During the random vibration in the radial axis two failures occurred in the counter assembly. The exhaust valve was locked in the open state and the gas system was non operational (See FR #006 Section 9.0). Analysis revealed that a copper tube from the gas reference volume to the gas electronic box had broken. These items were returned to the University of Wisconsin for repair. Manufacturer analysis of the exhaust valve was to show that wrong parts were installed in the valve. The copper tube was replaced with a stainless steel equivalent. Standart QTP tests were given before and after the vibration sequence. No electrical nor mechanical deterioration, other than noted above, was observed. Reference Section 8.1.9, 8.1.10, 8.1.11, and 8.1.12.

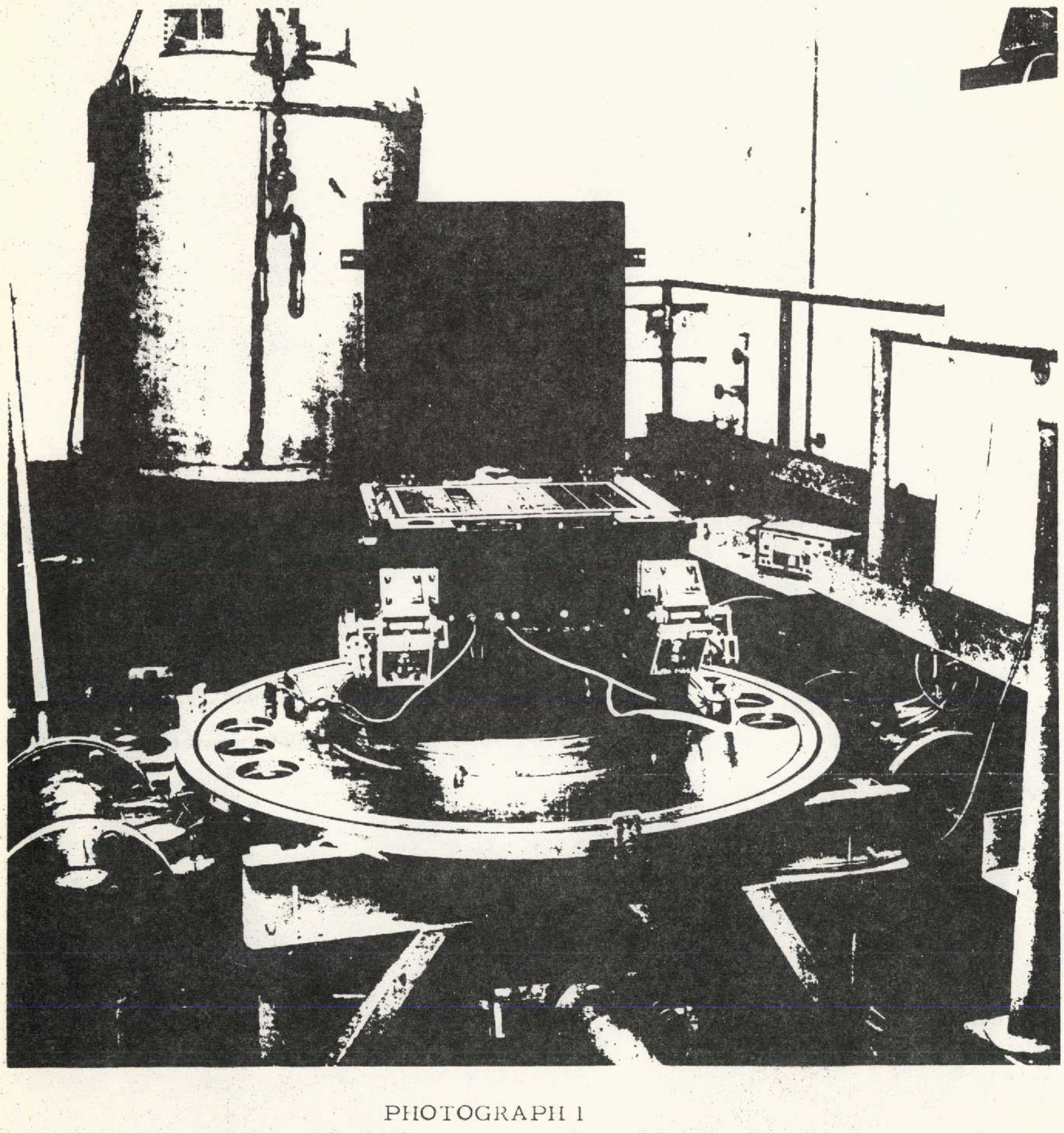
VIBRATION #3 DATE: October 23, 1972

The vibration test was performed per paragraph 5.0 of the Acceptance Test Plan 1629-005 Revision B, using a flight window. The sensor successfully completed both sine and random in all axis.

At the completion of the test sequence a wire to the calibrate solenoid had become loose and was easily repaired, the exhaust valve was temporarily stuck in the open position and was fixed by flushing clean gas thru it so a small foreign comtaminate was probably the cause of the valve sticking. The absolute pressure transducer was acting as a differential transducer because of loss of its vacuum reference. The pressure transducer, a C.F.E. item, was removed and sent directly to the manufacturer for repair and analysis. The Standard QTP tests were given before and after the vibration sequence. No electrical nor mechanical deterioration, except as noted above, was observed. Reference Section 8.1.13.

THERMAL VACUUM - FIRST ATTEMPT ON OCTOBER 27, 1971

Thermal Vacuum Requirements presented major difficulties in keeping a thin (flight) window intact when first attempted at Wyle labs in Huntsville. Several attempts were made to pump down and were terminated when the thin window ruptured. Attempts at further pumping were discontinued for a study of the window problem. By later direction, reference, "Minutes from MSFC Meeting Concerning S-150 Testing" direction was given to do two types of Thermal Vacuum testing. First a test with storage window so that the target attitude may be maintained and all electronics properly tested and second, a test with a flight window qualifying little more than the flight window itself. The standard QTP test was given the sensor before testing was begun and is included in Section 8.1.4.



PHOTOGRAPH 1

THERMAL VACUUM SETUP

1-12

WYLE JOB NO	42184
NOD NO	42184-1
PO NO	73109
DATE	11-4-71

NOTICE OF DEVIATION

WYLE LABORATORIES

TO: SCI

ATTN. Mr. Jim Cobb

PART NAME X-Ray Experiment

PART NO. S-150 SERIAL NO N/A

TEST Thermal Vacuum

SPECIFICATION SCI Work Statement PARAGRAPH NO 4.0

NOTIFICATION MADE TO: Mr. D. Norris

DATE 11-4-71 BY Witness VIA N/A

SPECIFICATION REQUIREMENTS:

The S-150 X-Ray Experiment shall be subjected to the Thermal Vacuum Test in accordance with SCI Work Statement, Paragraph 4.0.

DESCRIPTION OF DEVIATION:

During the performance of the Thermal Vacuum Test, the SCI Representative indicated that components of the S-150 X-Ray Experiment had failed to function properly. These malfunctions occurred in one of the solenoid relays and a membrane seal. Because of the malfunctions, the SCI Representative stopped the test and rescheduled it at a later date. However, other conditions experienced during the Vibration Test led to the elimination of the thermal vacuum requirement.

SPECIMEN DISPOSITION Test sequence continued with acoustic testing.

COMMENTS · RECOMMENDATIONS

DISTRIBUTION:
Original: Department
( ) Copies: Customer
1 Copy: Quality Control
1 Copy: Field Engineering
1 Copy: Project Office
1 Copy: Contracts

TEST WITNESS ______ TEST ENGINEER [illegible signature]

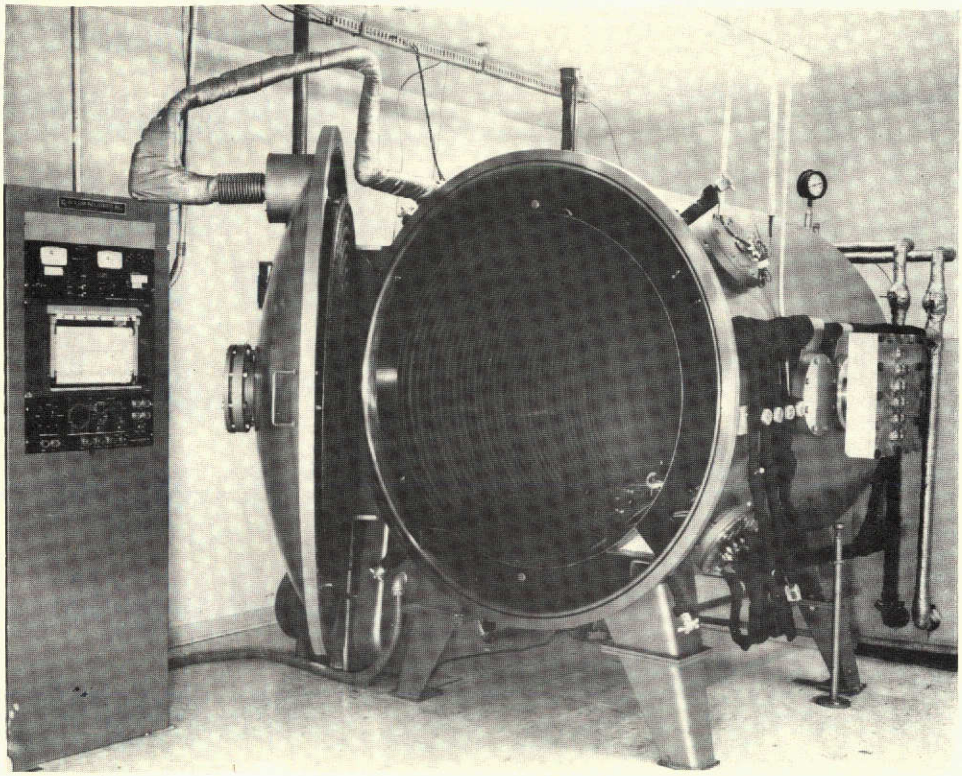
REPRESENTING ______ BRANCH HEAD [illegible signature]

THERMAL VACUUM Date: August 16, 1972

The storage window type of thermal vacuum test was accomplished at the SCI Systems Test Facility. The entire test was run in accordance with paragraph 5.0 of the Qualification Test Plan -005 and also to Section #10 of the Qualification Test Procedure -001. The sensor was mounted on a cold plate within the chamber and the Pre T.V. test sequence done as specified in Paragraph 10.1 of QTP -001. After stabilization at 325,000 feet operational electrical data was taken and all systems were nominal. The chamber temperature was then reduced to -30°C, (-0, +5°C). Analog data was taken during the two hour stabilization period and an ATP test was given at the end of two hours. A single reading was high by 50 mv and was written up. Later analysis of the measurement showed this condition to be a normal one and the measurement tolerances were opened up to cover this drift at low temperature.

Reference Failure Report #004 in Section 9.0. The chamber temperature was raised to 45°C (+0, -5°C) analog data was taken for each 30 minutes. After two hours of stabilization the analog monitors indicated an increased gas leakage thru the storage window. The sensor power was briefly interrupted in order to allow the chamber pressure to return from $\approx$ 510 microns to $\approx 2 \times 10^{-4}$ mm at which time the sensor was again powered and the chamber pressure again rose to near 150 microns. At this unrealistically low vacuum and with the increased window leakage the test was terminated. See Failure Report -005 in Section 9.0.

Mr. S. Rose COR MSFC has agreed that the basic objectives of the test were accomplished, that is, no carona discharge, arcing, and proper electrical operation in vacuum conditions and thus the last ATP of this test was waivered. The Standard QTP test was given before and after the test sequence and no evidence of mechanical or electrical deterioration could be noted. Reference Section 8.1.8.



MANUFACTURER	MODEL NO.	DESCRIPTION
Vacuum Industries, Inc.	6300/4800 48 in. dia. x 54 in.	High Vacuum Chamber Temperature: -100° to 250°F (Shroud) -320°F ultimate with LN_2 Pressure: ambient to 1 x 10^{-5} **Torr (1 x 10^{-7} Torr ultimate)**

THERMAL VACUUM Date: 11-7-72

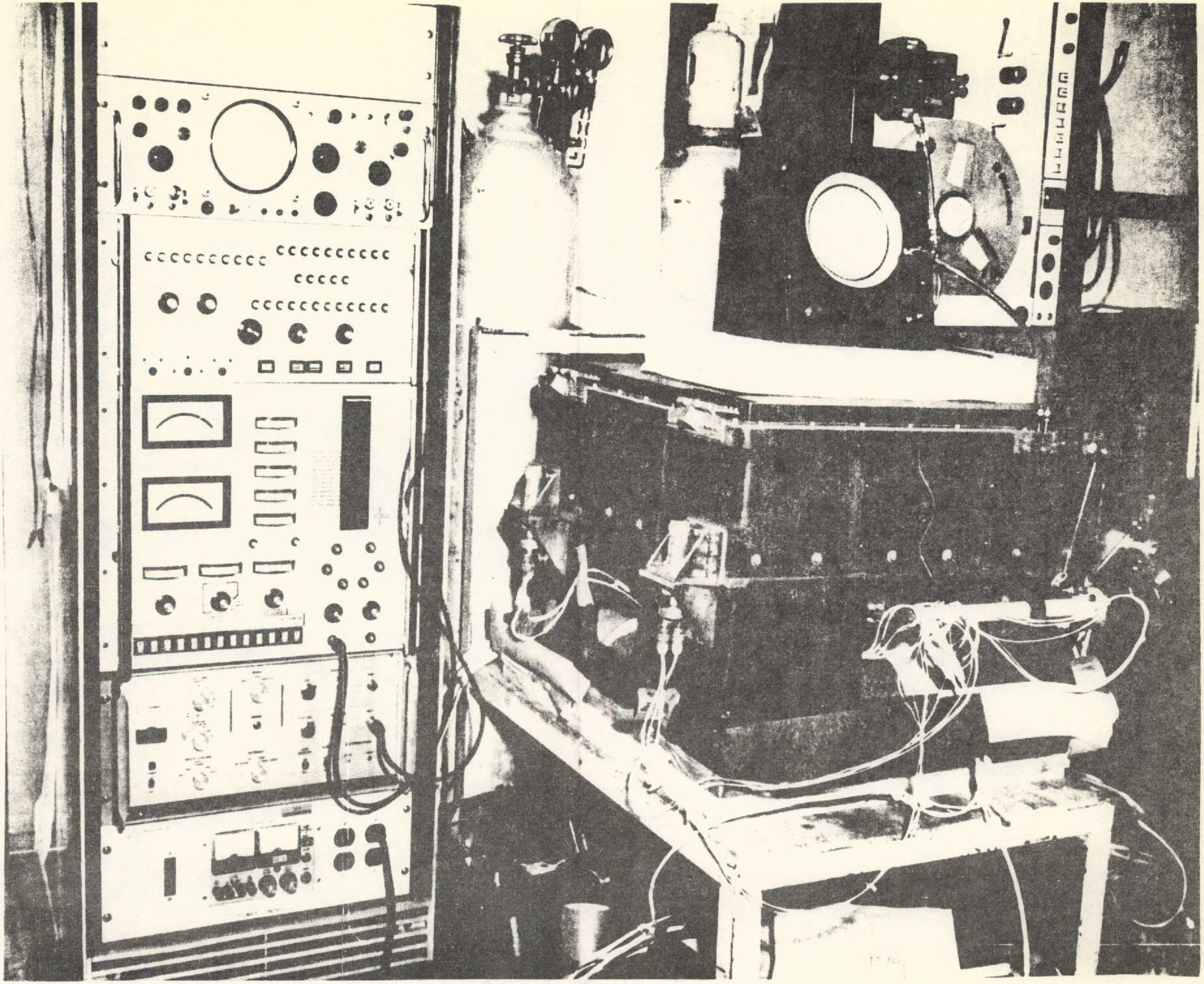
The flight window type of thermal vacuum test was accomplished at the SCI Systems Test facility using the identical flight wondow that had experienced the vibration test just prior to this test.

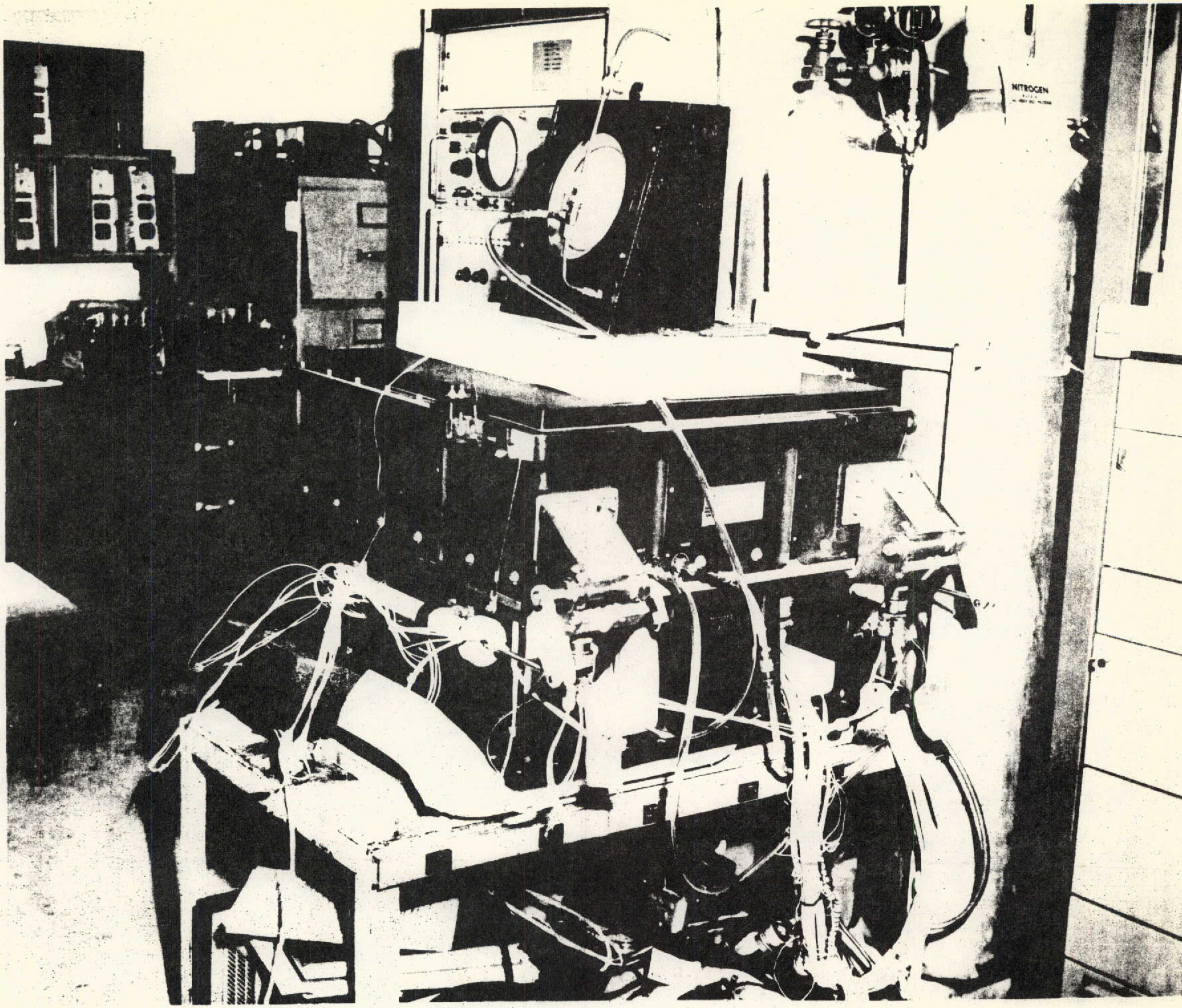
The previous thermal vacuum run on August 16, 1972 had adequately demonstrated and qualified the S-150 Electronics and mechanical interference. With the philosophy that the objective of this T.V. test was to demonstrate that the thin flight window was flight worthy this thermal vacuum test was run without electrical stimulation. See letter of authorization from University of Wisconsin dated October 30, 1972, in Section 16.0.

The window leak rate was monitored continuously during the entire test sequence. It should be noted that the window (flight) leak rate did increase during the -30°C period of two and one half hours and stabilized at the new rate after about one hour into the cold cycle. No further increases in leak rate were noted during the remainder of the test at +45°C and the post T.V. leak rate test. For information and evaluation,the leak rate increased from 1 Torr per minute to approximately 17 Torr per minute at the conclusion of the Thermal Vacuum Testing at 16 psi. The conditions under which the sensor was asked to perform was definitely worst case. An unavoidable delay of five days allowed contamination to penetrate the delicate window and obviously allowed some deterioration. In addition due to unknown circumstances a pressure bottle was shut down allowing a majority of the positive window pressure to leak away and thus allowing some of this contamination to become lodged between the colliminator backing and the delicate window. In actual pre-launch conditons these circumstances could never occur. An electrical Post T.V. ATP was given and the sensor showed no deterioration electrically. Reference Section 8.1.13.

PYROTECHNIC SHOCK

Immediately after Thermal Vacuum post ATP check the live squibs were placed within the actuators and fired from two 12V car batteries in series. Inspection immediately after the firing determined that all ordinance had fired and all bolts had separated. A post ATP was given and no change in the condition of the sensor unit could be noted, either electrically or mechanically. Reference data sheets Section 8.1.14.



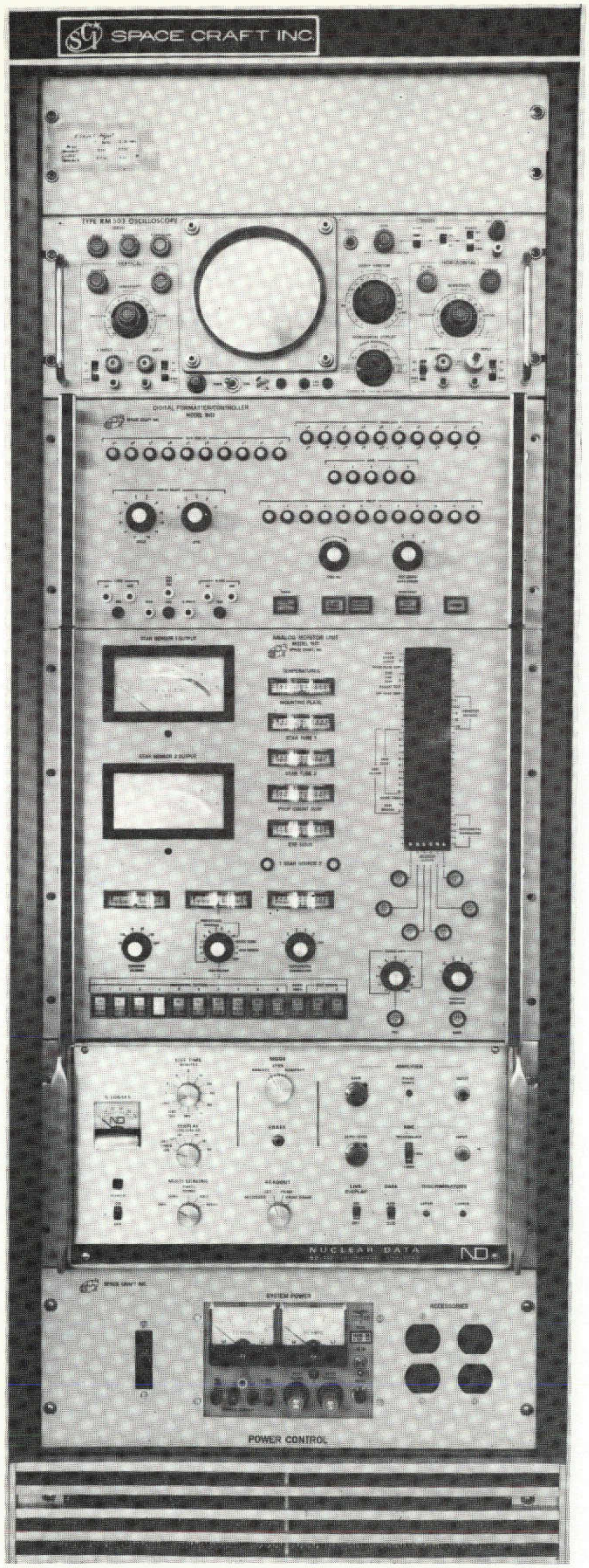

NITROGEN

6.0 GROUND SUPPORT EQUIPMENT

The S-027 Ground Support Equipment was modified and used for the S-150 experiment. The modification included adding additional command capability for the gas exhaust value, and re-naming some channels/functions.

A photograph of one set of the modified GSE is shown in Figure 6.0-1.

Each of the two identical consoles contains an oscilloscope, a 128 channel analyzer, an analog processing and display unit, a digital processing and display unit and a system power supply. In addition to the equipment contained in the console, the Ground Support Equipment includes a Strip Chart Recorder, a Pulse Generator and a Line Printer. The digital and analog processing units interface with the experiment and are the heart of the Ground Support Equipment. These units will be discussed further in the following sections.



GROUND SUPPORT EQUIPMENT,
X-RAY ASTRONOMY EXPERIMENT

6.1 ANALOG PROCESSING AND DISPLAY UNIT

The analog processing unit provides displays for the twenty-five analog data channels in the form of meter readouts and GO/NO-GO indicator lights. Each channel is also routed to a patch board to allow recording the data on external recorders. The five supplemental analog measurements which are not active channels in the experiment, but are included to provide additional measurement capability to the Ground Support Equipment, are also displayed on the analog panel.

6.2 DIGITAL PROCESSING AND DISPLAY UNIT

The digital unit provides information to the experiment Digital Data Processor which is normally provided by the launch vehicle instrument unit such as timing and synchronization pulses. The digital outputs from the experiment are analyzed and displayed by lights on the Digital Front Panel.

Selector switches are included to allow selection and display of any of the twelve data groups and any of the five ten bit words contained in each data group.

In addition to the digital data display, commands to apply experiment power, open or close the exhaust valve and calibrate the experiment originate in the unit and are activated by lighted pushbutton switches.

7.0 CONCLUSION

The S-150 experiment was integrated to Vehicle #207 with few problems, and was flown at 7:08 EDT on 28th July 1973. The sensor provided normal engineering data and apparently good x-ray data for approximately the first two hours. The sensor was then inadvertently maneuvered so that it scanned into the sun for a period of about 17 minutes. About 5 minutes into that sun time the kimfoil window leak rate increased to the point where the electronic regulator was cycling very rapidly. This caused the 30 psi supply line pressure to drop and not be able to provide the necessary gas flow. Thus, the sensor pressure began to drop and the counter H. V. supply was automatically turned off ending the useful life-time of the experiement.

The technical operation of the S-150 experiment, both pre-flight and flight, was nominal and x-ray data was observed during various periods of the active experiment life-time.